UNIVAC®

COVER PHOTO. Gold-plated connectors used in NTDS Computer.

Military Department

REMINGTON RAND UNIVAC®

DIVISION OF SPERRY RAND CORPORATION

Univac Park

St. Paul 16, Minnesota

SYSTEMS

COLOR PHOTO. Confusing? Not to a computer. These wires are automatically routed to the correct terminals by a UNIVAC mechanized design process.

Operator's view of the UNIVAC 1105.

When the Military Department of Remington Rand Univac was called upon to develop a ground-guidance computer for the ICBM Titan, it was specified that the computer possess the then unheard-of reliability of 99.4%—and be delivered in months. Few realized that such a computer, the ATHENA®, would be delivered, not only two months ahead of schedule, but with a reliability that exceeded specifications. Yet, that's what happened.

Before and since the development of ATHENA, Remington Rand Univac has been a pioneer in the search for advanced electronic systems of data processing and control. A significant list of UNIVAC contributions in the field include:

1946—development and production of the first commercial magnetic storage drum.

1950—completion of UNIVAC I®, first large-scale, general purpose electronic digital computer for business applications.

1950—delivery of the UNIVAC 1101, first commercially produced digital computer for scientific applications.

1952—delivery of the UNIVAC SCIENTIFIC® Model 1103, first on-line scientific computer.

1952—delivery of the impedance-matching Automatic Antenna Coupler.

1953—completion of the UNIVAC flight plan storage system for automatically accepting, storing, and delivering flight plans and weather information.

1955—development of the UNIVAC File Computer, combining commercial data processing with large storage capacity and rapid access.

1955—development of UNIVAC II, providing flexibility of instruction repertoire with the attachment of a magnetic core memory.

1956—delivery of the first solid state computer, the Cambridge Air Force Computer.

1957—delivery of the ATHENA Guidance Computer for the Titan Missile System.

1958—delivery of the first commercial solid state computer, combining the advantages of large-capacity storage, microsecond access, and simultaneous processing of input-output units.

1959—delivery of the UNIVAC SCIENTIFIC Model 1105, a high-speed digital computer with great programming versatility and large internal and external storage capacity.

1960—announcement of UNIVAC III, a solid state computer having a processing speed nine times faster than UNIVAC II.

1960—delivery of the Target Intercept Computer for the Nike Zeus anti-missile system.

1960—delivery of the LARC, fastest and most versatile solid state computer, to the Livermore Atomic Research Center.

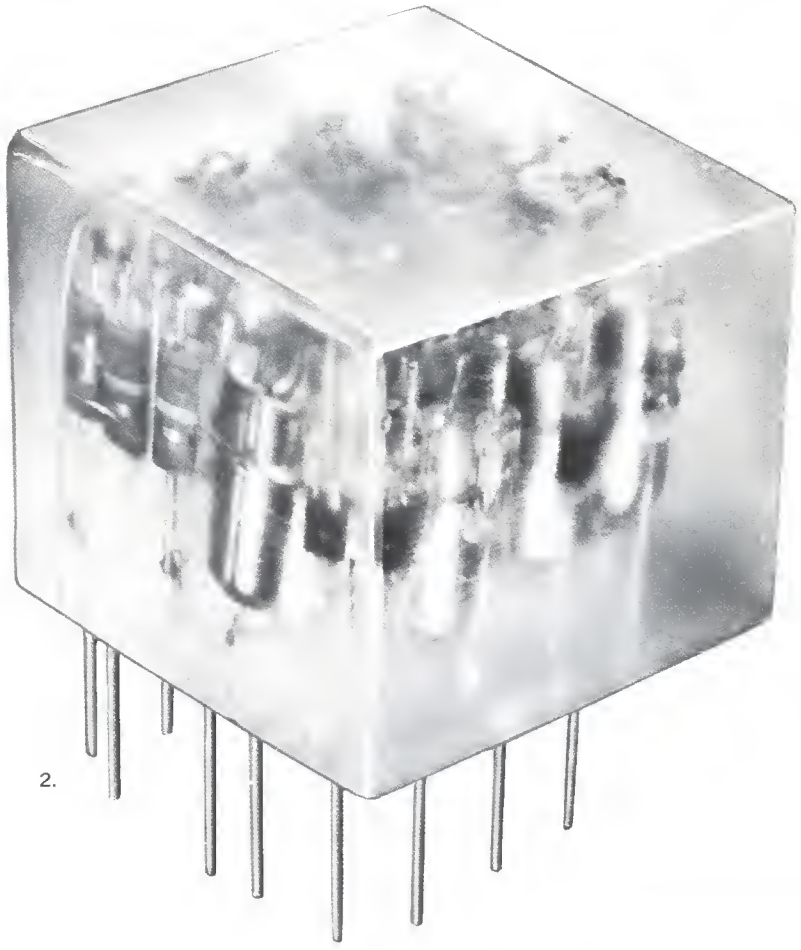
1960—announcement of new advanced UNIVAC 490 Real Time System—a breakthrough for the management of many kinds of business data.

1960—announcement of UNIVAC 1107 Thin Film Memory Computer—the first computer to use magnetic thin films operating in nanoseconds or billionths of a second.

THE MILITARY DEPARTMENT'S PROJECTS

The Military Department of Remington Rand Univac specializes in military applications of data processing and computing systems. Located in St. Paul, the Department maintains a staff which includes nearly 1,500 professional mathematicians, scientists, and engineers. It has six plants encompassing nearly one million square feet of floor space. As a part of the Sperry Rand Corporation, the Department is linked with the talents and facilities of more than twenty-five major divisions, including such leaders in the field of military developments as Sperry Gyroscope Company (and its many divisions), Ford Instrument Company, and Vickers Incorporated. The Department draws on the facilities and experience of these organizations and participates in programs with them, as well as with the Remington Rand Division research and development centers in Philadelphia and Norwalk, and with production centers in Utica and Elmira. The facilities and capabilities of the Department are complete—ranging from design and development to manufacturing, installation, and support—from the development of hardware to the production of complete military systems. Current projects under various stages of development exemplify the Department's range of capabilities.

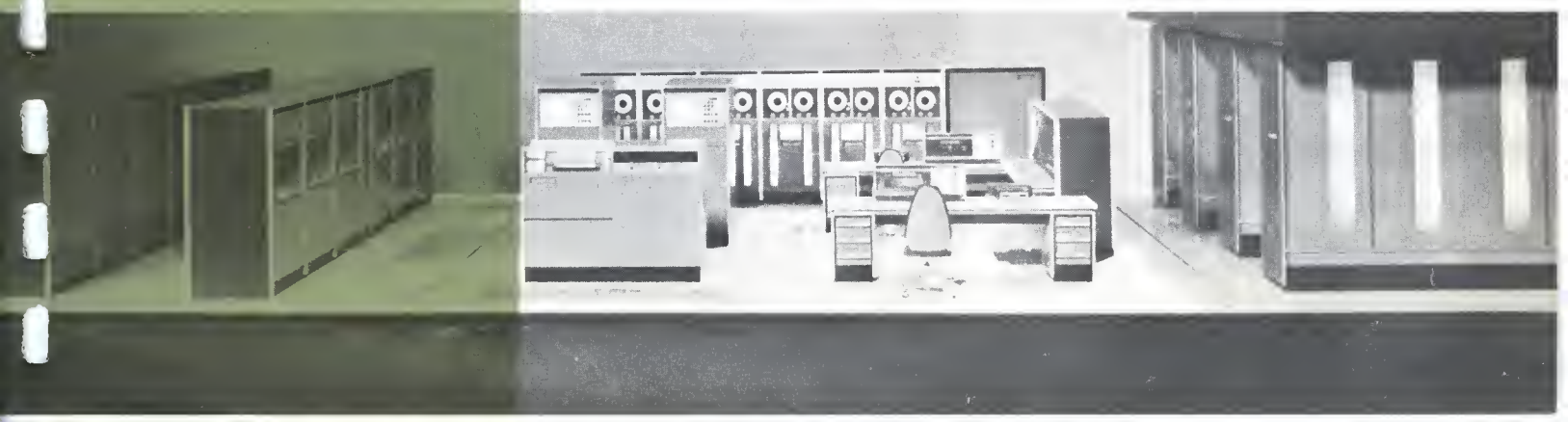
The NAVAL TACTICAL DATA SYSTEM (NTDS) is a computing system developed to counter the power of nuclear weapons with the speed of electronics. An extremely compact, high-capacity, integrated, information processing and transmission system, NTDS provides the

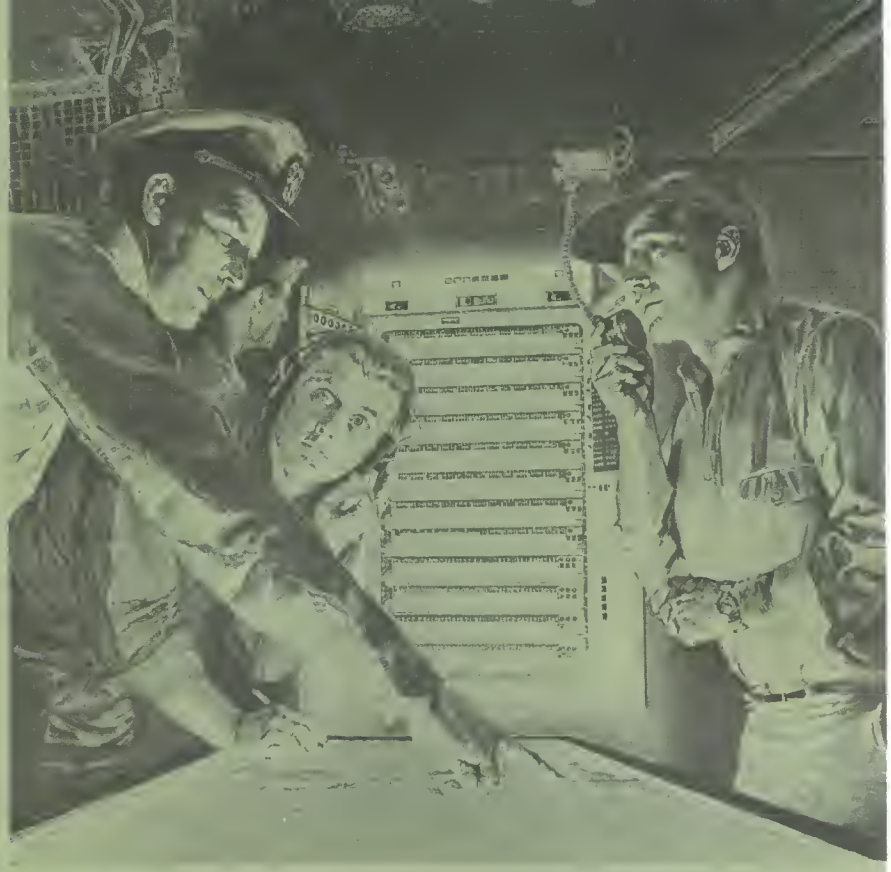


2.

1. Memory designer in a reflective mood—RANDEX Magnetic Storage Drum.
2. "Sample package": welded circuit assembly.
3. The UNIVAC LARC.

3.





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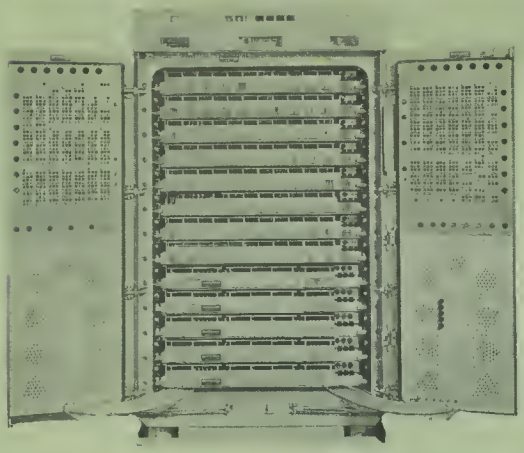

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Navy with a major advance in its ability to conduct warfare. It collects, processes, and evaluates tactical data from radar, sonar, and other communication sources and recommends courses of action in virtually "zero" time. Computers aboard the units of a widely deployed naval task force exchange information which, when added to information already stored, provides complete knowledge of the over-all tactical situation. All echelons of the command have the ability to disseminate their orders automatically and at high speeds. This high-speed communication between computers enables all units in the task force to operate in a coordinated fashion, as though the task force were one ship.

The Tactical Air Control System (TACS) was designed for the U.S. Air Force to provide a presentation of an air situation as it develops. TACS provides mobile analog and digital equipment capable of operating under difficult field environmental conditions. When used together with radar and communications equipment, the system supplies the operating command with data necessary to direct and control air operations. TACS handles target detection, identification, automatic tracking, automatic data processing, ground-to-ground and ground-to-air communications, automatic intercept, interdict, and return-to-base computations.

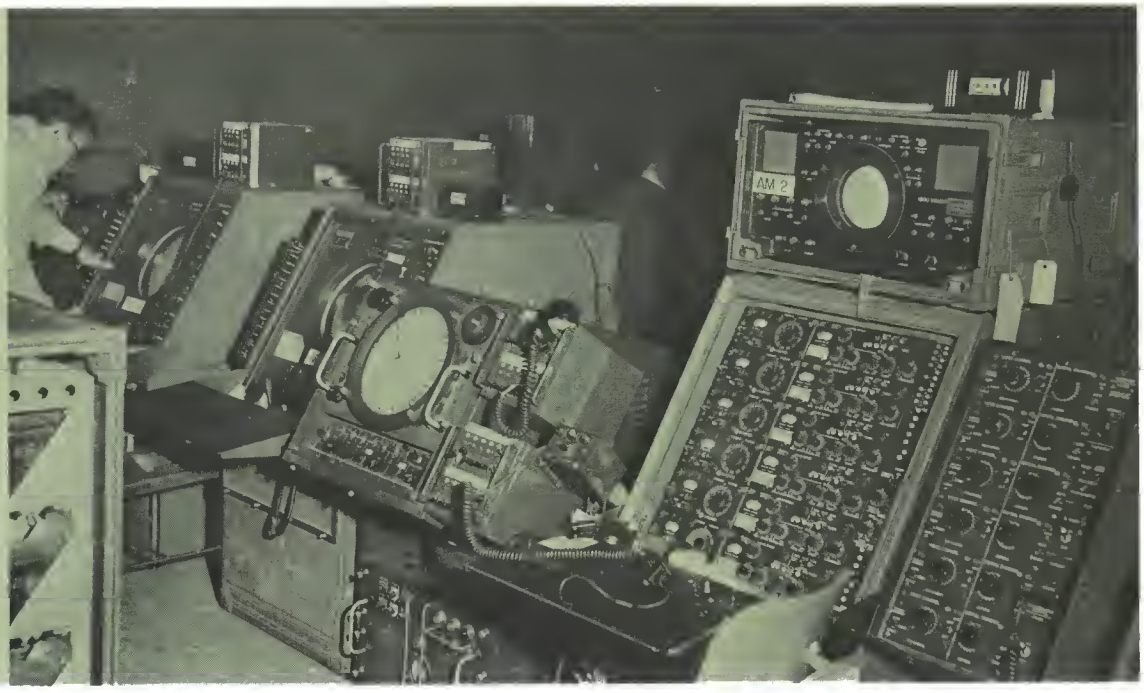
Because of TACS' diversified characteristics, it is exceptionally adaptable to the over-all problem of air traffic control. One of its functions, the control of return-to-base operations, is particularly suited for use at both commercial and military air control stations. Modular design suggests many possibilities for use at both large and small airports.

The Univac Automatic Antenna Coupler was designed and built in response to the demands of jet-age radio communications. Couplers are lightweight, hermetically sealed, solid state devices built to withstand the requirements of long-range supersonic flight under severe, high-altitude conditions. They are capable of automatically matching changing impedances between antenna and transmitter. Their average tuning time is three seconds. Continuous research and development in couplers are directed at even greater efficiency and more extensive applications. The Automatic Antenna Coupler is used by most major airlines, by military aircraft, by naval vessels; wherever environment varies the impedance presented by an antenna.

The Univac Athena is a digital guidance computer for the Air Force ICBM Titan. It tracks and controls the missile during its initial powered flight, guiding it into a trajectory which will put it on target. The computer continually monitors speed, elevation, direction, azimuth, and position of the missile, comparing this information with data stored in its magnetic memory. Responding in milliseconds, the Univac Athena computes and transmits the corrective action necessary to keep the missile on course, and cuts off missile power at the required time.

The Athena computer's exceptional reliability has resulted in its use in such space programs as Thor Able II and Project Echo. For the latter project it was used to launch the TIROS I and TIROS II weather observers into their planned orbits—and did so with an eccentricity of less than three thousandths, achieving the most nearly circular orbits of any satellite to date. The development of the Athena computer set a new standard of computer reliability. Such Univac systems as the NTDS and the Target Intercept Computer for Nike Zeus are being developed with equal or greater reliability.

The Univac Target Intercept Computer (TIC) was designed for what the Army has termed the most advanced missile in the U.S. defense system—the



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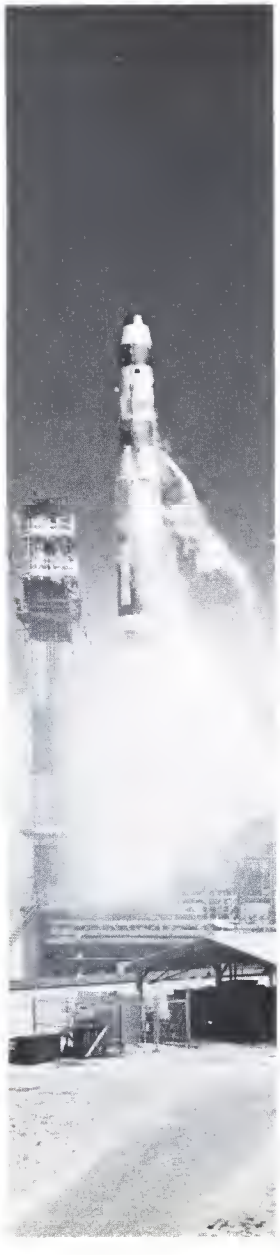

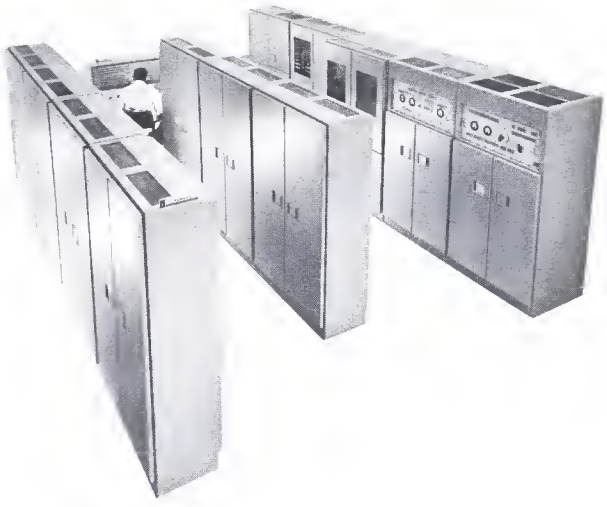

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1. NTDS—automatic computer system capable of decisions in virtually "zero" time; an example of UNIVAC'S total systems capability.
2. UNIVAC 1206 (AN/USQ-20) Military Real Time Computer.
3. Tactical Air Control System.
4. ATHENA Guidance Computer for ICBM Titan.

1-2. Nike Zeus Anti-Missile with Target Intercept Computer.
3. Airline Reservation Agent Set.

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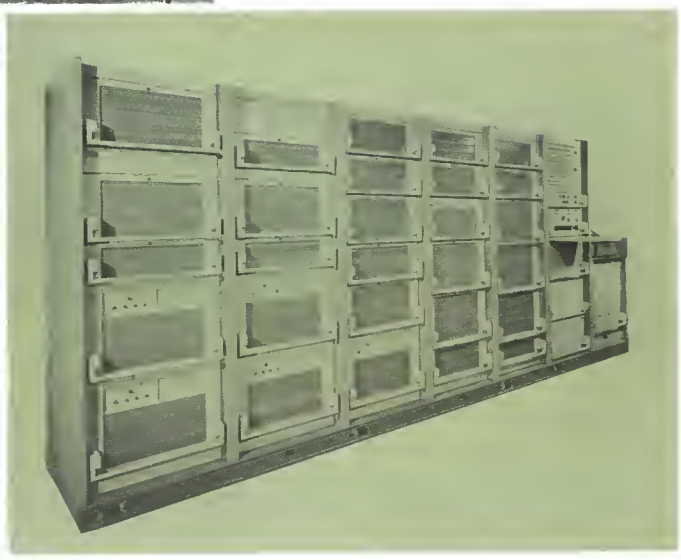

Nike Zeus. Extremely fast and reliable, TIC tracks the enemy missile, predicts the exact time and place of intercept, and sends steering orders to guide the anti-missile to its target. It continues computation up to the last moment of guidance when it instructs Nike Zeus to burst and destroy the enemy missile. Modular construction, transistorized circuits, and manufacturing process control over all components have resulted in the achievement of ultimate speed and capability while holding down future mass production costs. The reliability of TIC is expected to exceed that of any other computer in existence today.

The UNIVAC AIRLINE RESERVATION SYSTEM is an on-line computer system used for solving passenger space control problems. It keeps an up-to-the-minute inventory of seats and accomplishes direct communication concerning that inventory between a central processor (or processors) and each reservation agent. It also maintains a current record of flight status; whether a flight is on time, early or late, the amount of time, and the reason for schedule changes. An input-output unit, the Agent Set, permits the agent to communicate with the processor. Two types of transactions are involved—first, inquiry about the status of the inventory (ASK transactions), and second, transactions which directly change the inventory (SELL, CANCEL, WAIT LIST and CANCEL WAIT LIST). The Airline Reservations System is both fast and reliable. It provides quick service while holding overbooking to nearly zero, and it is fast enough to insure that available seats are sold. It performs one to one-and-a-half transactions per second, with response time to the agent of one second locally and ten seconds on the telegraph connections.

The UNIVAC AIR TRAFFIC CONTROL SYSTEM is a digital information processing system designed to handle and store flight plans and weather information. Messages are received and sent out by the system automatically over standard teletype lines. Requests for stored information and directions to change it are also transmitted by teletype. Messages are randomly filed in a magnetic drum store and subsequently found by means of their content. A complete logical plan gives a specific result for each possible action; questionable or erroneous messages are printed out for supervisory review. The Air Traffic Control System is currently being used by the Federal Aviation Agency.


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Univac Real Time Computer Systems

At present, four such computers have been developed. The Univac 490 Real Time System is a solid state system featuring a large, expandable, high-speed core memory—fast access, high density drum storage—large capacity disc storage—and high internal speed. Flexible input-output capabilities make it suitable for standard commercial data processing systems as well as real time applications. The Univac 490 System combines high reliability with minimum space, low power and low air conditioning requirements, and ease of maintenance; has both real time and delta clocks.

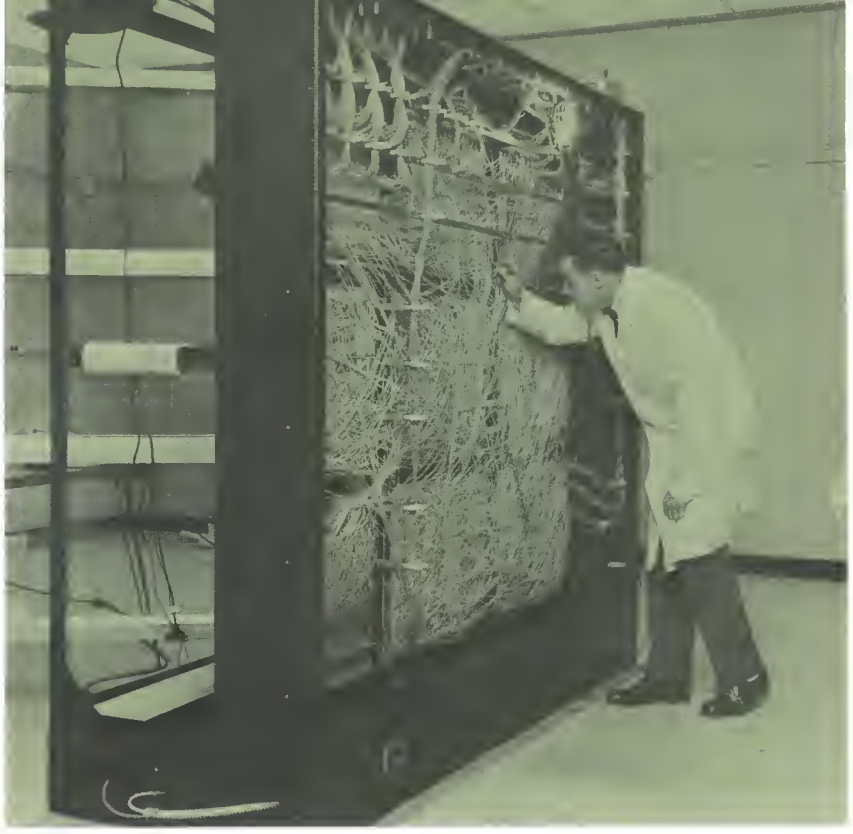
The Univac 1206 Military Real Time System is a stored-program computer for rapid processing of large quantities of complex data. It emphasizes random-access storage and ease of communication with a wide variety of external devices. Internal operations are performed in the parallel binary mode, with a 30-bit instruction word and either a 15- or 30-bit data word. Instructions are of the one-address type, with an average execution time of 16 microseconds. Built to rigorous military environmental specifications (MIL-E-16400), the Univac 1206 computer will operate reliably under severe conditions of shock and vibration and is well suited for shipboard, trailer, and airborne applications.

The Univac 1107 Thin Film Memory Computer is a medium-scale solid state system for use where reliable solutions are

required to complex off-line or real time on-line problems. A versatile input-output section, large capacity internal memory, and powerful instruction repertoire give the computer extensive capabilities in data processing. Advanced solid state technology provides high computational ability at low cost. The UNIVAC 1207 MILITARY REAL TIME COMPUTER is similar in function and operation to the UNIVAC 1107 computer, but is designed to military specifications.

UNIVAC Real Time systems and computers are suited for applications such as:

Tactical Data Systems
Tactical Control
Digital Communication and Switching
Data Reduction and Analysis
Range Instrumentation
Real Time Guidance
Logistics, Inventory, and Scheduling
Traffic Control and Reservation
Simulation
Intelligence Systems
Scientific Computation
Computational Analysis



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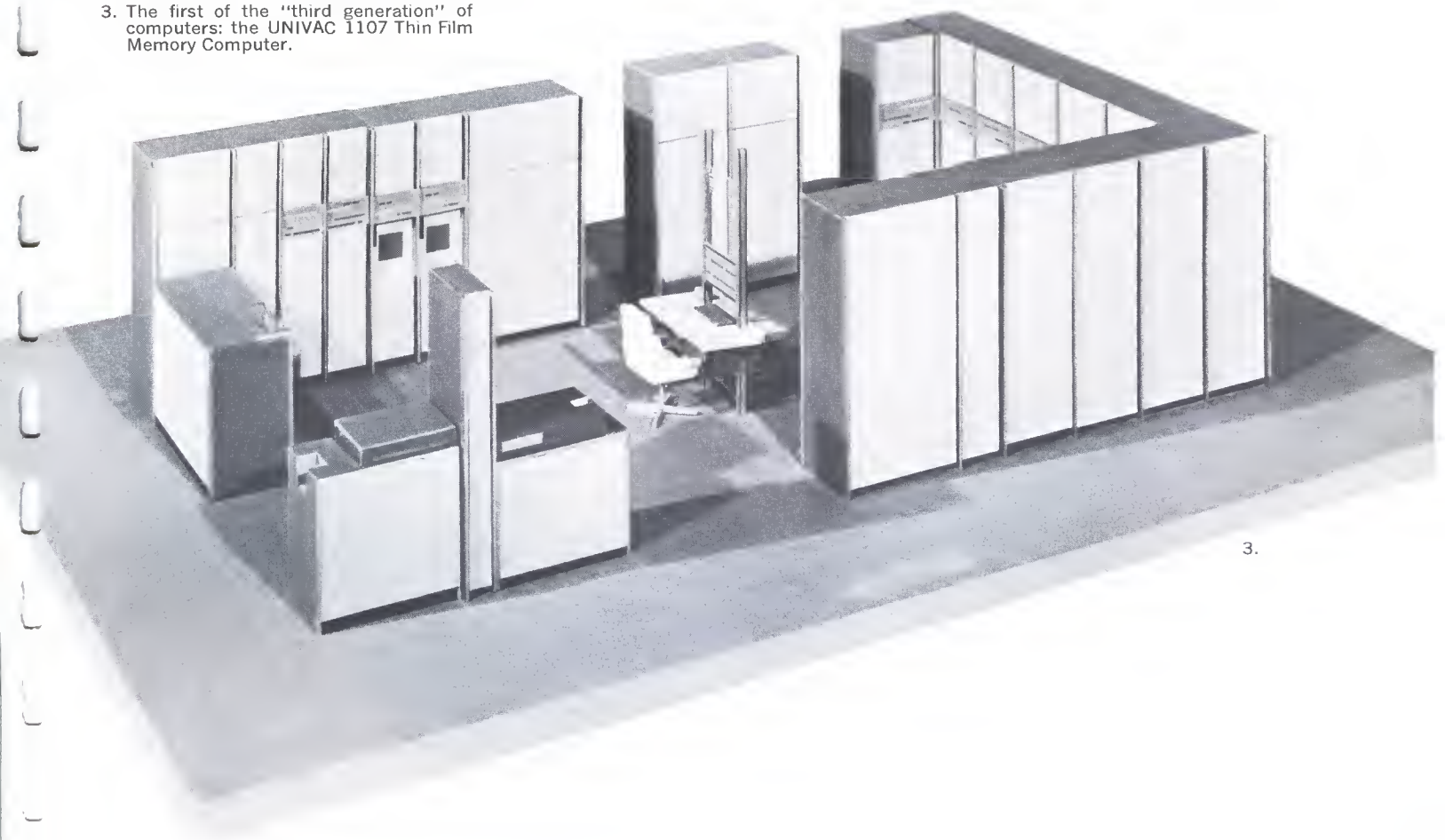
1. Heart of the Air Traffic Control System.
2. Skeleton for the UNIVAC 490 Real Time System.
3. The first of the "third generation" of computers: the UNIVAC 1107 Thin Film Memory Computer.



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1. Printed circuit master.
2. Wash day for printed circuits.

UNIVAC's background in *information storage and retrieval* has resulted in a complete capability for the design and development of information systems. UNIVAC research has, for several years, performed full time investigations in information storage and retrieval. Much knowledge has been gained through research—much experience acquired through applications of information system theory to practice.

UNIVAC capability in information retrieval was exemplified by the March, 1960 issue of *Federation Proceedings*. For the first time a computer (UNIVAC I) was used on a practical basis for programming a large scientific meeting—and for preparing a standard book index. The 2,526 papers presented at the annual meeting of the Federation of American Societies for Experimental Biology, April 11-15, 1960, were indexed and scheduled in less than eight hours of computer time. Done manually, an estimated 30 man-weeks of time would have been spent on these activities.

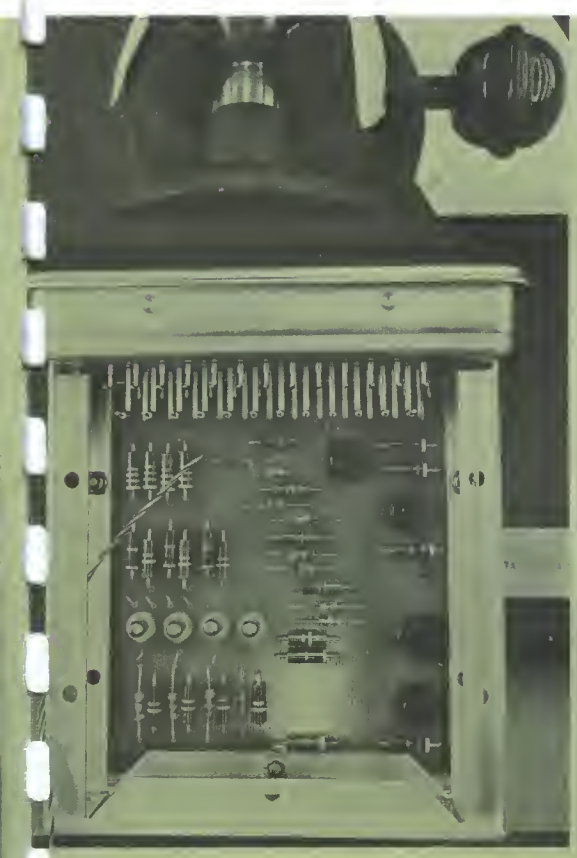
UNIVAC has also been working with the Armed Services Technical Information Agency in the development of an information retrieval system for their needs. ASTIA is using the UNIVAC Solid State Computer for processing an average of 2,000 requests for documents per day. A typical subject search might be to locate all documents relating to the use of a particular fuel in missiles. The initial size of the file to be searched by the system—about 250,000 documents.

HOW THE MILITARY DEPARTMENT WORKS

Much of the success of the Military Department can be attributed directly to the organizational planning through which military programs are implemented. The assignment of personnel from line areas to groups working on specific military programs has made possible the integration and coordination of programs through all phases—planning, design, development, testing, manufacturing, installation, and support. This is the project group concept—closely knit teams with unity of purpose working on programs where morale and dedication are indispensable to successful outcome. This, too, is the philosophy of concurrency, with all phases of a program being considered and worked on simultaneously. Such coordinated efforts have made possible the achievement of new standards in reliability; and the development and production of systems in record time.

Complementing and supporting the activities of the projects are SPECIAL SERVICE GROUPS which supply facilities and personnel in the fields of quality control engineering, production engineering, production control, inspection, and prototype equipment testing. One such group, Fabrication and Assembly, operates a plating and etching laboratory, model shops, a printed circuit laboratory, and a drum assembly group. Fabrication and Assembly provide assembly rooms and manpower, organized into production areas, to speed every phase of fabrication for a project.

Another group providing support to the projects is ENGINEERING SERVICES, which combines finest laboratory facilities with engineers and scientists trained and experienced in materials, processes, and components. This division includes specialists in such areas as stress analysis and shock testing—all available to projects as needed. A Materials and Processes



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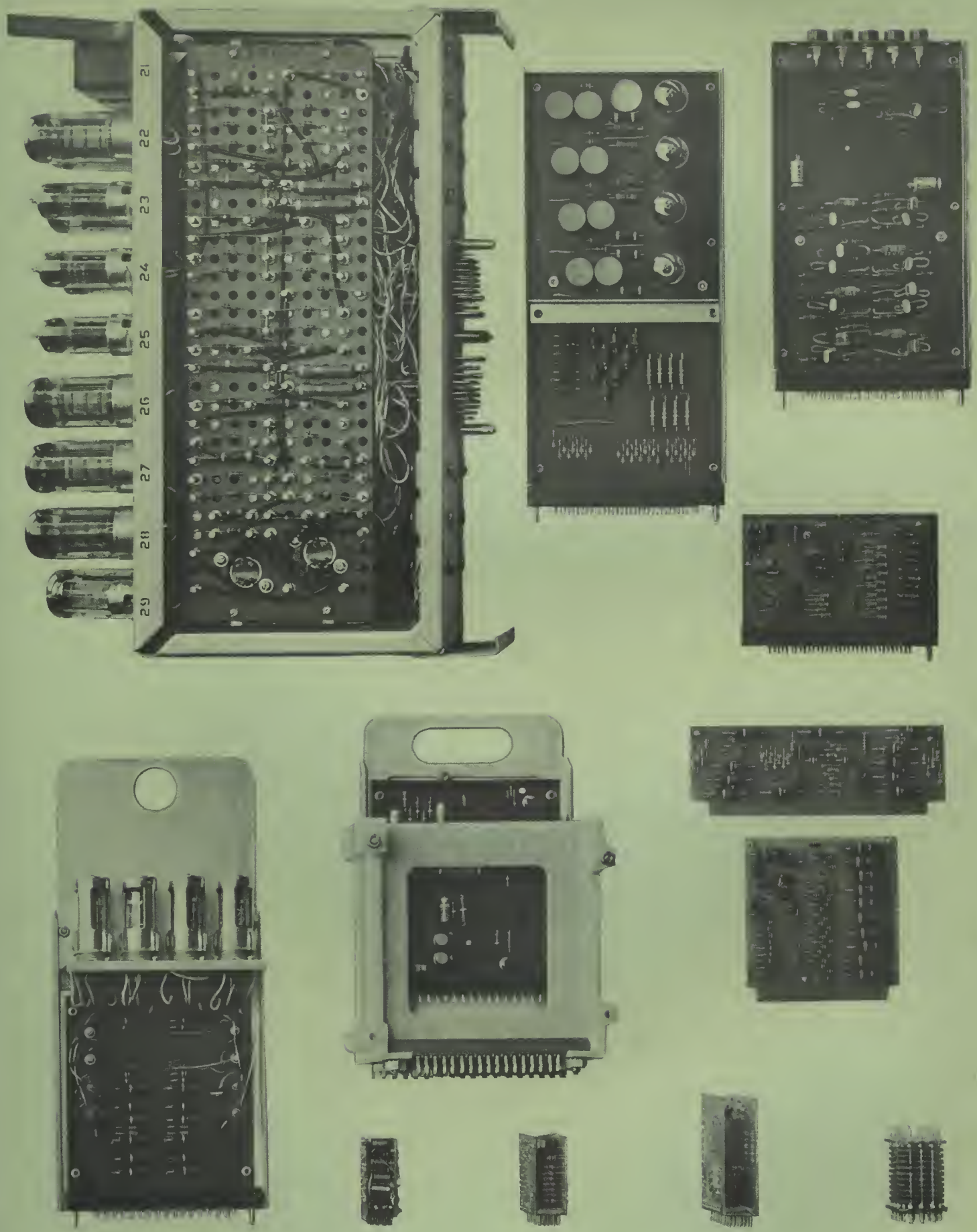
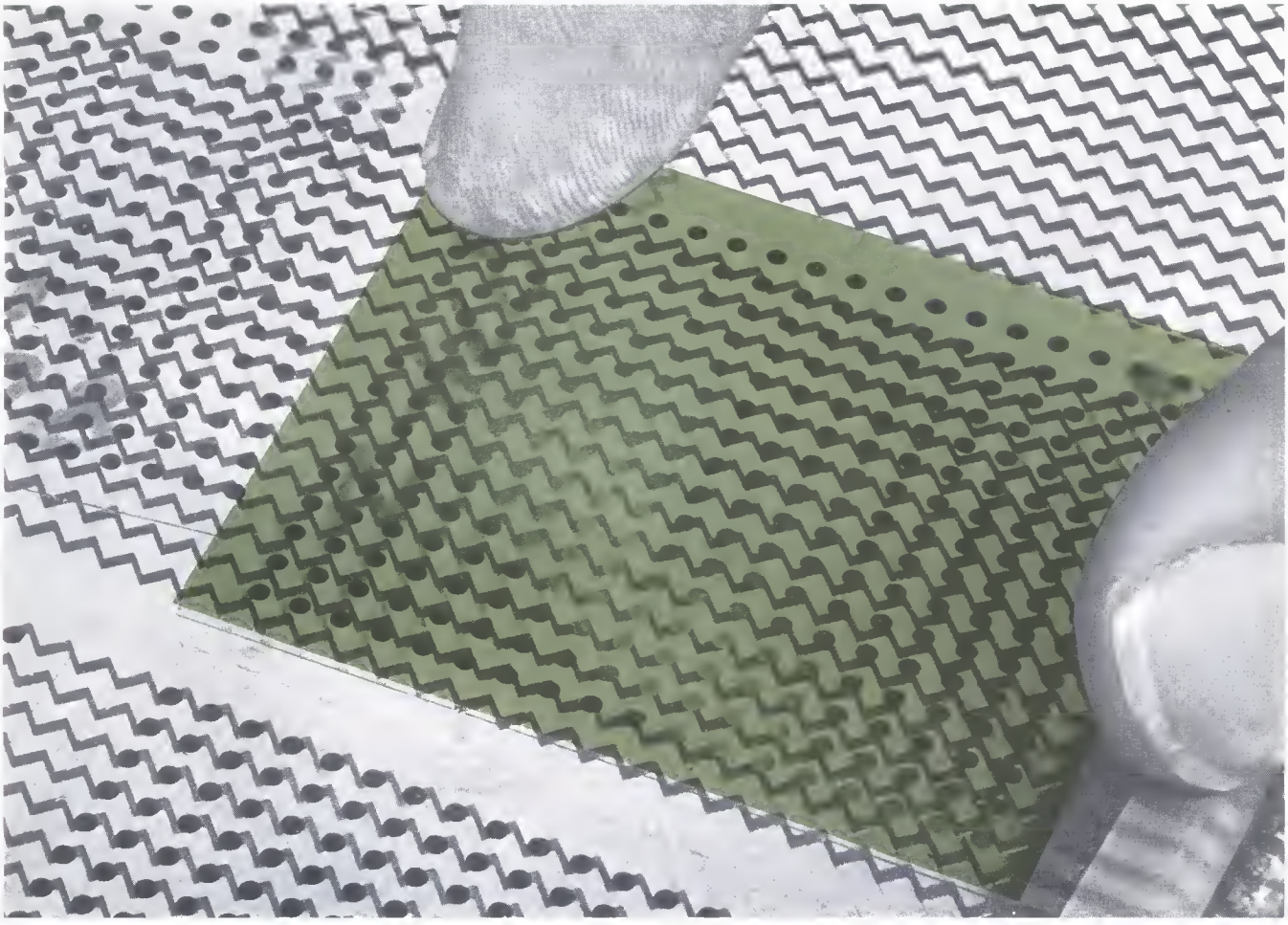
3. Logic module assembly.
4. Evacuating modules.
5. Sealing modules ready for final test.





1. Progression of chassis design from 1950.
2. Magnetic film memory assembly.

2.

Laboratory provides testing facilities for all materials used in military systems; carries out metallurgical, photographic, chemical, and spectrochemical investigations. A Components and Systems Test Laboratory provides nearly every conceivable test to assure that UNIVAC equipment will withstand severe environmental conditions. Systems and components are subjected to such environmental and stress hazards as heat, cold, humidity, fungus, impact, and vibration; designed to meet or exceed military specifications. A Design Standards group, staffed by experienced personnel, is available for recommending standards for projects. A Publications group produces a wide variety of technical reports for military projects—and translates technical data into manuals, instruction books, motion picture films, slide films, and other documents for military use. Other groups supporting project activities are directly concerned with problems of cost, efficiency, and speed of delivery.

The DATA APPLICATIONS group is involved in a specialized application of information retrieval; serves as a central source for all data needed to build sophisticated hardware. Because of the speed required—where design, development, and production are often occurring simultaneously—the importance of an information retrieval operation to system development is apparent. It provides a flow of standardized information throughout the project and between projects. It eliminates overlap of work, allowing all projects the advantages of data accumulated and work accomplished in other areas. This support operation makes it possible to predict early in a program what will be needed in facilities, manpower, and components to produce what is being worked on in the design stage. A new concept proven feasible and now being applied is in the area of provisioning documents. The Data Applications center is equipped to handle the data and prints (in any form) from all contractors—and to combine them into one provisioning document in a form compatible with the customer's needs.

All administrative sections of the Military Department are oriented to the needs of the military. A prime example is Purchasing whose objective is effective procurement with considerations of quality, delivery, price, and service. In performing this function, Purchasing maintains history records on all purchased parts; keeps quotation histories of all UNIVAC controlled drawings and specifications; maintains vendor ratings by evaluations and compilations of historical data. The handling of a formalized Small Business Program is also the responsibility of Purchasing. This program is actively promoted; in fact, 60% of the Military Department's 2300 suppliers are classified as small business concerns. To implement its objectives, Purchasing employs its own group of graduate engineers who work closely with both vendors and customers. The Purchasing operation is

mechanized through the use of the UNIVAC File Computer and the UNIVAC II computer.

APPLICATIONS ENGINEERING is another group completely oriented to military requirements. These are the engineers who are responsible for applying UNIVAC developments to military needs. To serve the military more effectively, Applications Engineering maintains offices in Washington, Los Angeles, Dayton, Boston, and St. Paul.

Operating under the Director of Military Applications, the Advanced Systems Research Group consists of scientists, mathematicians, engineers, and operations analysts performing research and analysis related to current and future computer applications. The Washington, D. C. location of the group permits close liaison with government, military, and industrial R&D activities.

RESEARCH

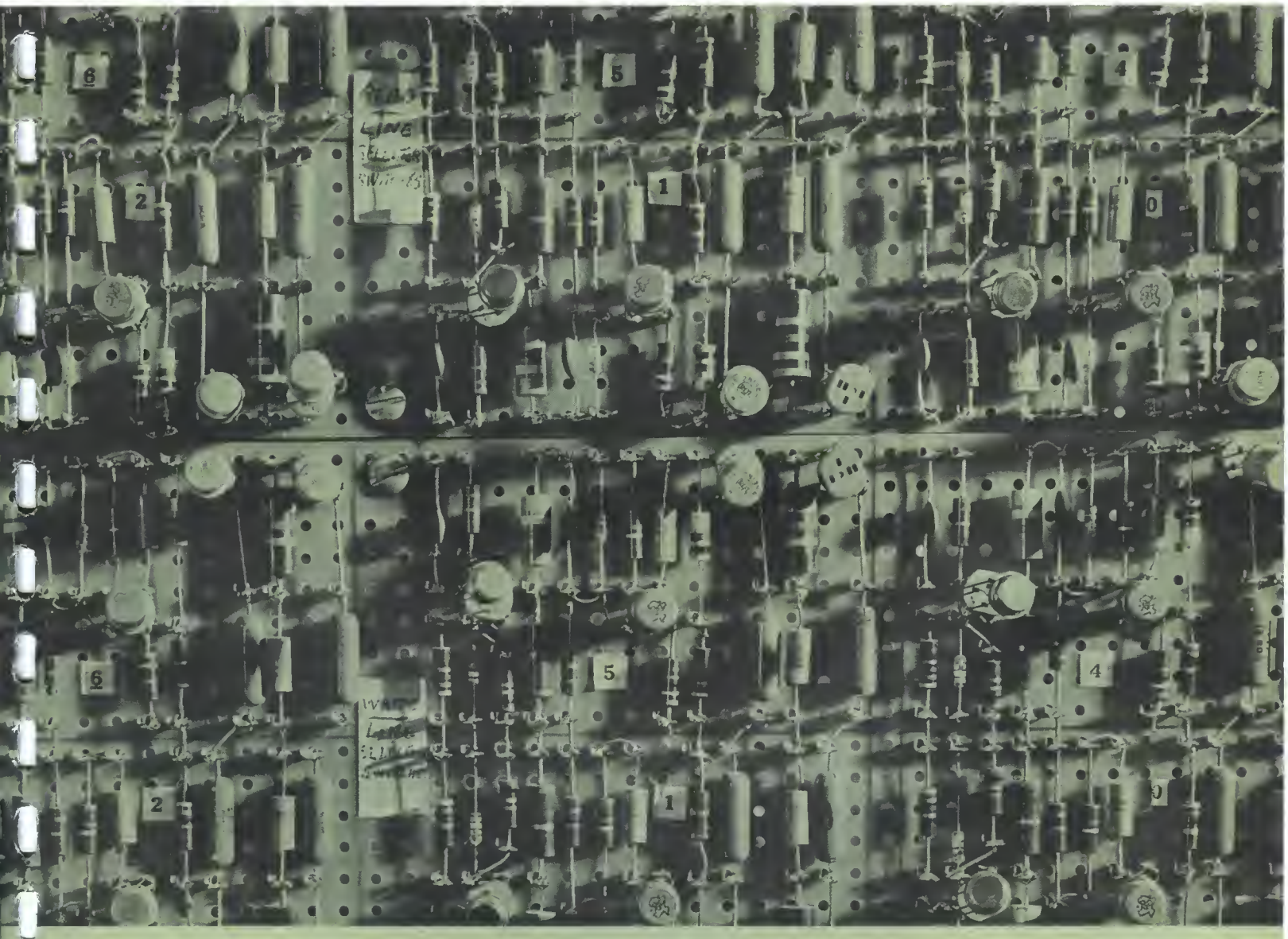
The investigation of components, materials, and techniques is a continuous responsibility of UNIVAC Research. The objective of such research is to develop advanced systems of data processing . . . equipment which will cost less initially, perform more speedily, have capabilities for solving more complex problems, require relatively minor programming efforts, be simpler and more economical to maintain and operate. In all areas, UNIVAC Research can avail itself of the talents and facilities of other organizations within the Sperry Rand Corporation. The Sperry Research Center in Sudbury, Massachusetts, is an example of such an organization.

One of the most promising current areas of UNIVAC research and development is ferromagnetic film. UNIVAC research in ferromagnetic film, magnetic ferrites, Unifluxors, logical circuits and components, and peripheral equipment is discussed in the research section of this brochure.

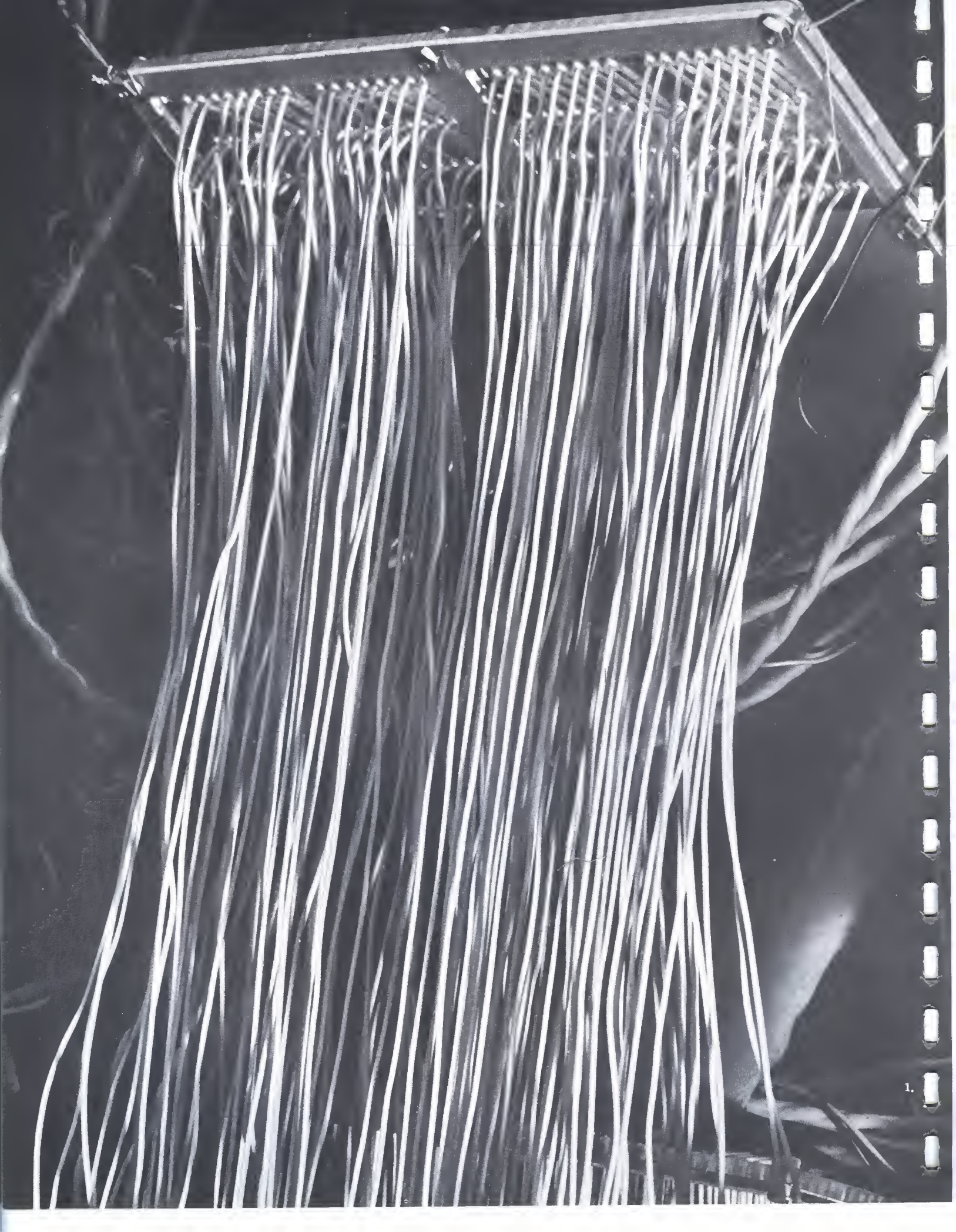
ENGINEERING

COLOR PHOTO. Careful component examination and analysis, even to cross-sectioning of diodes like this, is one of the keys to system reliability.

Engineering service begins literally when a project is no more than a problem to be solved. An advance planning group of technical specialists is available to work with the customer prior to any contract or proposal; in fact, even before specifications are written. This group (System Planning) assists the customer in defining his objectives and requirements. It participates in planning the research and development program, with particular attention to the requirements of future military systems. Composed largely of mathematicians, physicists, and systems analysts, the System Planning group provides the nucleus for the task force of a specific job.

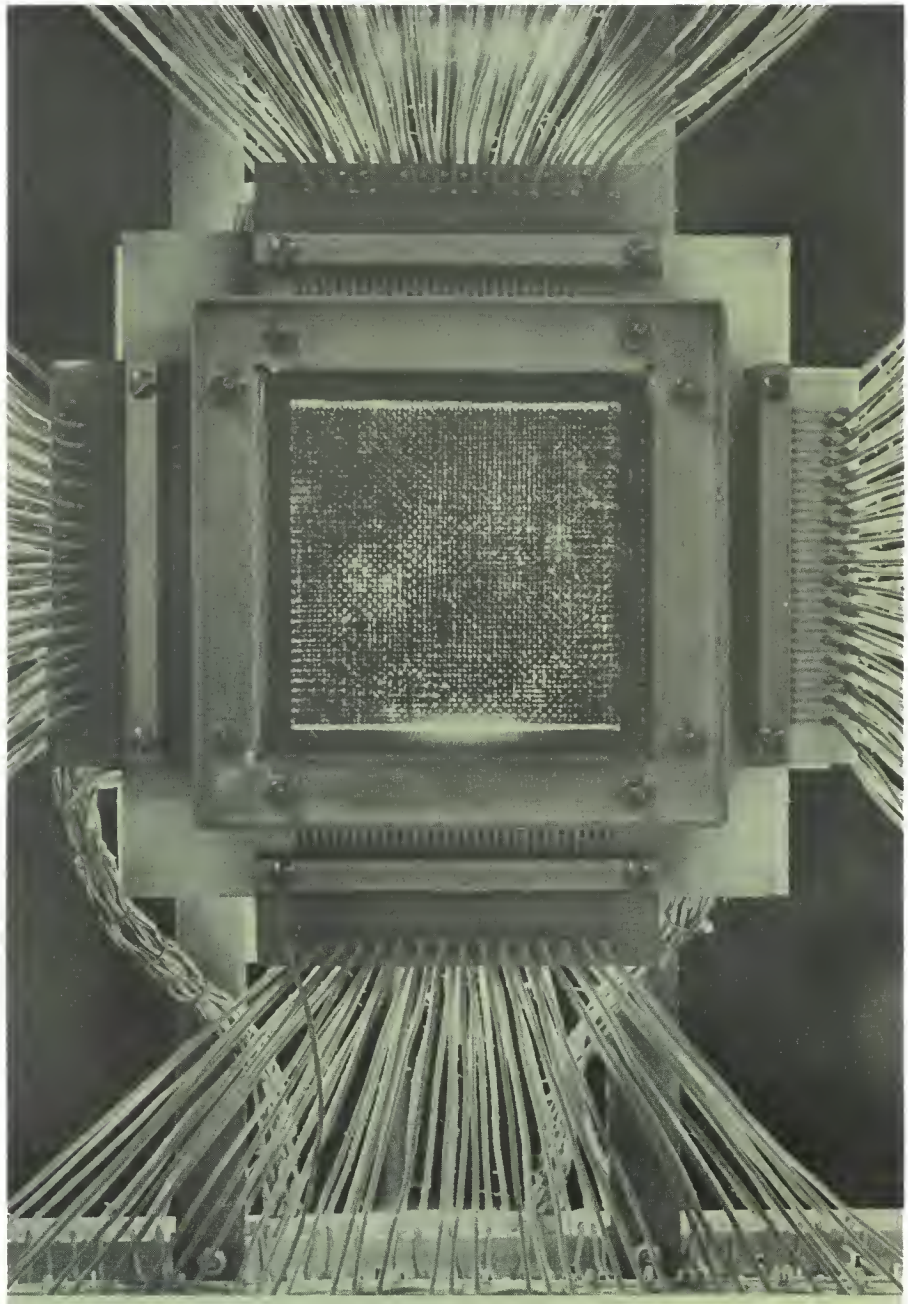


Breadboard for new computer: engineering creativeness at work.



1.

Once a project's objectives have been defined, personnel, techniques, components, and materials are coordinated within a project group for solving the problem. Such project groups have the responsibility for the development of UNIVAC Systems . . . the ATHENA ground-guidance computer for the ICBM Titan which set new reliability standards for the entire industry . . . the extremely fast, reliable, easy-to-maintain Target Intercept Computer for Nike Zeus . . . the large scale, real time Naval Tactical Data System, including complete peripheral equipment, keysets, communication terminals, video processors, programming, and a compiler system to minimize time and effort to make the system operational . . . the Tactical Air Control System for the Air Force, providing the



2.

1. Spaghetti, computer style: wiring jig for the UNIVAC Solid State.
2. Testing a UNIVAC III core memory matrix.

information needed to monitor the air space in a large geographical area . . . the Air Traffic Control System for handling, storing, and retrieving flight plans and weather information . . . the Antenna Coupler which automatically solves the problem of matching changing impedances between antenna and transmitter . . . the on-line Airline Reservation System which solves airline passenger-control problems . . . the Sea Surveillance System, enabling the operating agency to control all vehicles in a geographical area. It is here—in research, design, development—that requirements of speed, cost, reliability, logistics and programming, and maintenance and operation are considered and resolved.

RELIABILITY IS A PROGRAM

Reliability at UNIVAC starts with analysis and is carried through all stages of design, development, production, installation, and operation. A central organization (Reliability Engineering) directs the Department's over-all reliability program during the design phase. It assigns a group of specialists to each project . . . including engineers trained in component engineering, failure analysis, specifications, and statistics.

Recognizing that reliability is a state of mind, everyone involved in the project—from chief engineer to assembler—is educated and trained to think and work in terms of reliability. Lectures, films, newsletters, posters, and program publicity are used to instill proper attitude and motivation. In addition, technical reliability data are distributed; failure analysis results are publicized.

Just how effective such concentrated reliability effort can be is reflected by the performance of computers such as ATHENA, developed for the ICBM Titan. This large digital machine has over 30,000 diodes, 10,000 transistors, and 35,000 resistors—and systems in the field are averaging better than 600 hours mean time to failure with a reliability of 99.95%. Another example, the Target Intercept Computer for Nike Zeus, will have even greater reliability. This level of reliability in military projects has been achieved partly through the development of new processes; but primarily it is the result of meticulous attention to sound engineering and manufacturing processes.

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1. "But is it reliable?"
2. U.S. Air Force Titan Missile.

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1. Resistors, resistors, resistors . . .
2. On target: shadow graph of terminal stud.
3. Automatic testing of transistors.
4. Chassis assembly for UNIVAC 1206 (AN/USQ-20).

CIRCUITS, COMPONENTS—WHERE RELIABILITY BEGINS

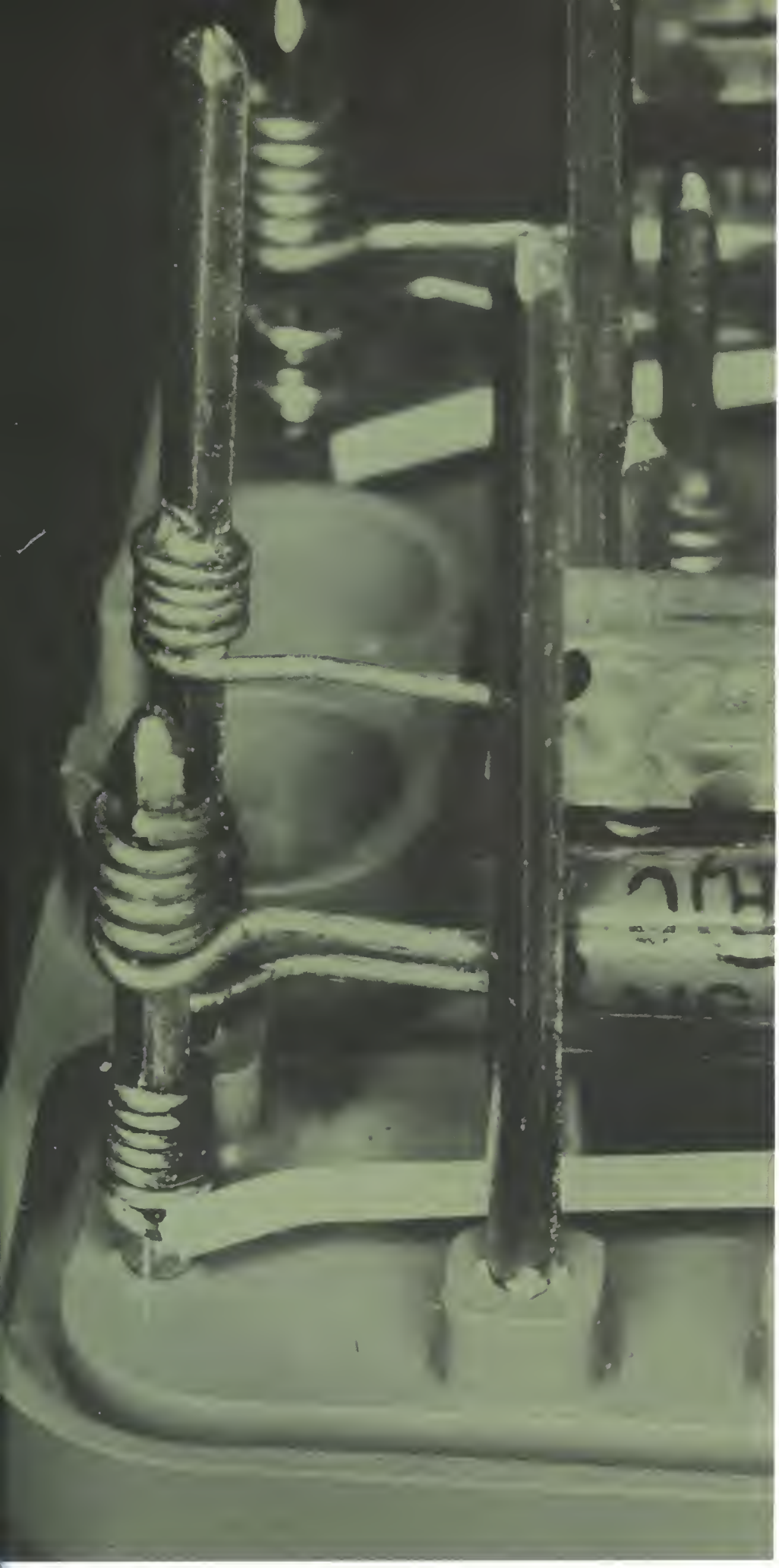
The most frequent causes of computer failure are faulty circuits and components. Special reliability efforts are directed to these areas. Circuits are designed with wide margins of safety—to tolerate realistic component degradation and to operate under anticipated environmental stress. All possible conditions that can affect circuits are simulated by mathematical equation—and solved by the UNIVAC SCIENTIFIC 1103 which calculates the optimum circuit. By use of this computer, it is possible to do reliably, in a few hours, what would take years of laboratory investigation.

Using a computer to design a computer is a technique developed by UNIVAC and now practiced extensively throughout the industry. This is the technique of *mechanized design*. Mechanized design is also used to prepare data for fabrication and assembly. Working from component configuration and chassis dimensions, the computer prepares and prints wire tabulations—including origin and destination of wires, wire length, and color coding.

Component reliability specifications meet the most rigid military quality requirements. Vendors' facilities are surveyed; and to insure compliance with specifications, quality control engineers are assigned to the vendors' plants to monitor production processes and testing. Large samples from every lot of components are subjected to destructive environmental and electrical-stress tests at both the vendor's plant and at UNIVAC. Tests under simulated use conditions determine the most frequent causes of failure as well as degradation characteristics of the chosen part. Finally every diode, every transistor, every resistor is checked with UNIVAC-designed Automatic Component Testers—and sorted into "accept" or "reject" categories.

Detailed attention to sound engineering processes ultimately determines system reliability—but reliability must begin with design. An example of reliability in design is ATHENA'S hermetically sealed chassis which protects the computer "building block" from environmental conditions. The sealed chassis is also an example of a solution to another primary design objective—*maintainability*—modular packaging which simplifies removal and replacement.

Maintainability is part of an over-all program of *human engineering* at UNIVAC. Industrial designers work with mechanical and logical designers to optimize the man-machine interface. When a project's operational requirements are established, a system of displays and controls is designed. Full-size mockups are built to study arrangement, size, and other physical factors. Controls, nomenclature, and devices are made operational on the mockup at the earliest possible date; thus laboratory evaluation simulating actual operating conditions can be made. Factors such as panel layouts, controls and indicators, colors, lighting, and ruggedness are explored in relation to the man-machine environment.



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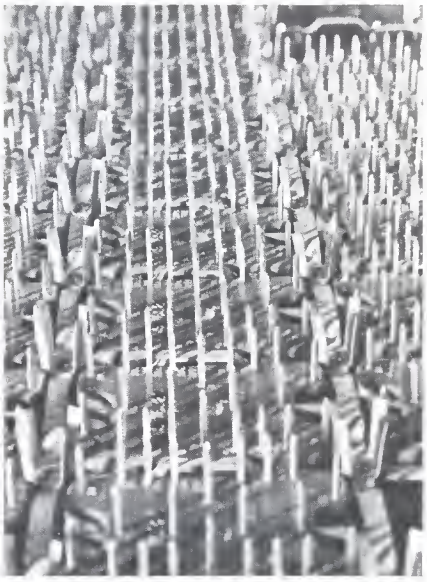
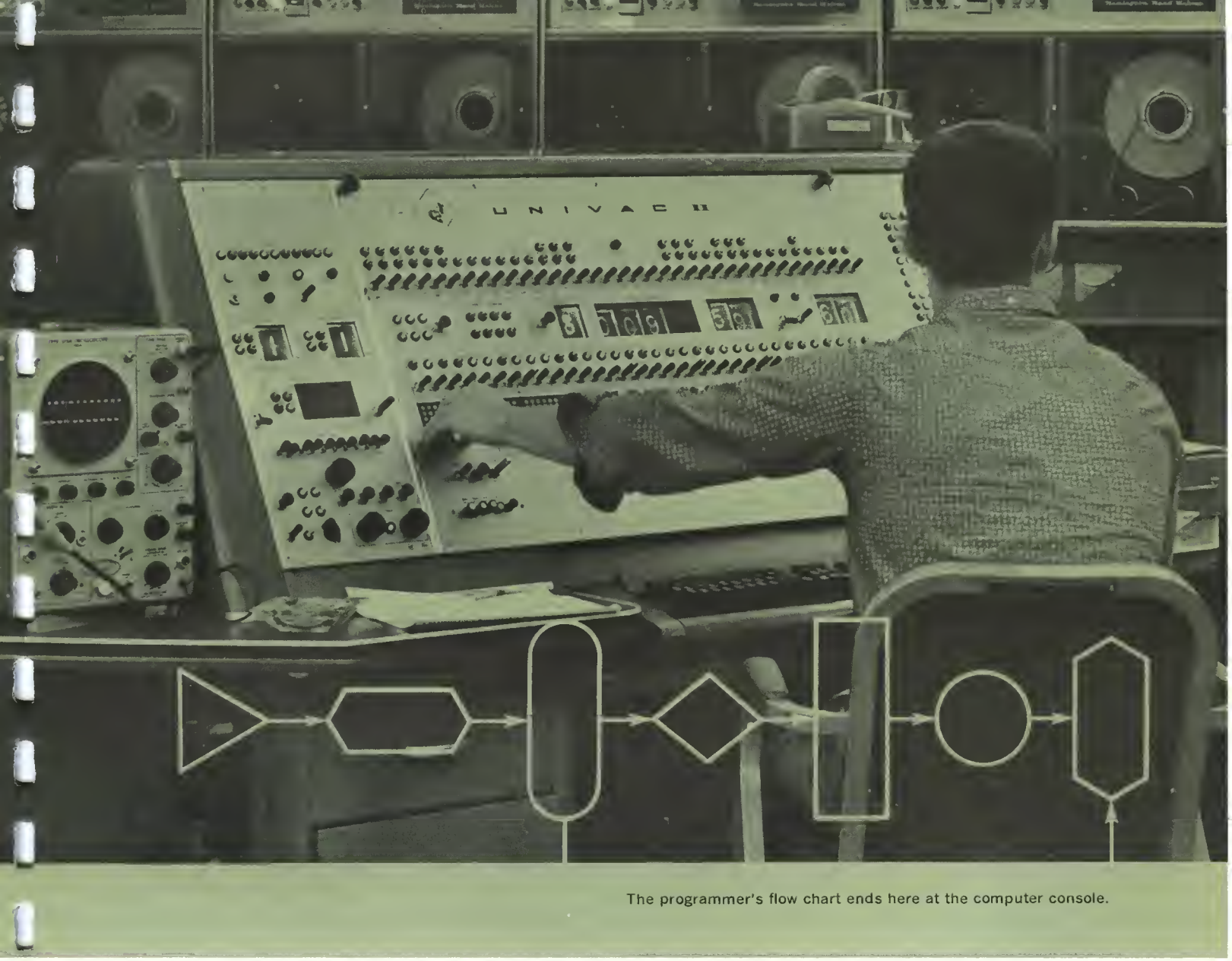


2.

1. Nike Zeus TIC module showing component assembly, connectors, and wire wrapping.
2. Nike Zeus TIC chassis ready for wiring.

PROGRAMMING

COLOR PHOTO. UNIVAC computers play an integral part in the development of advanced programming techniques.



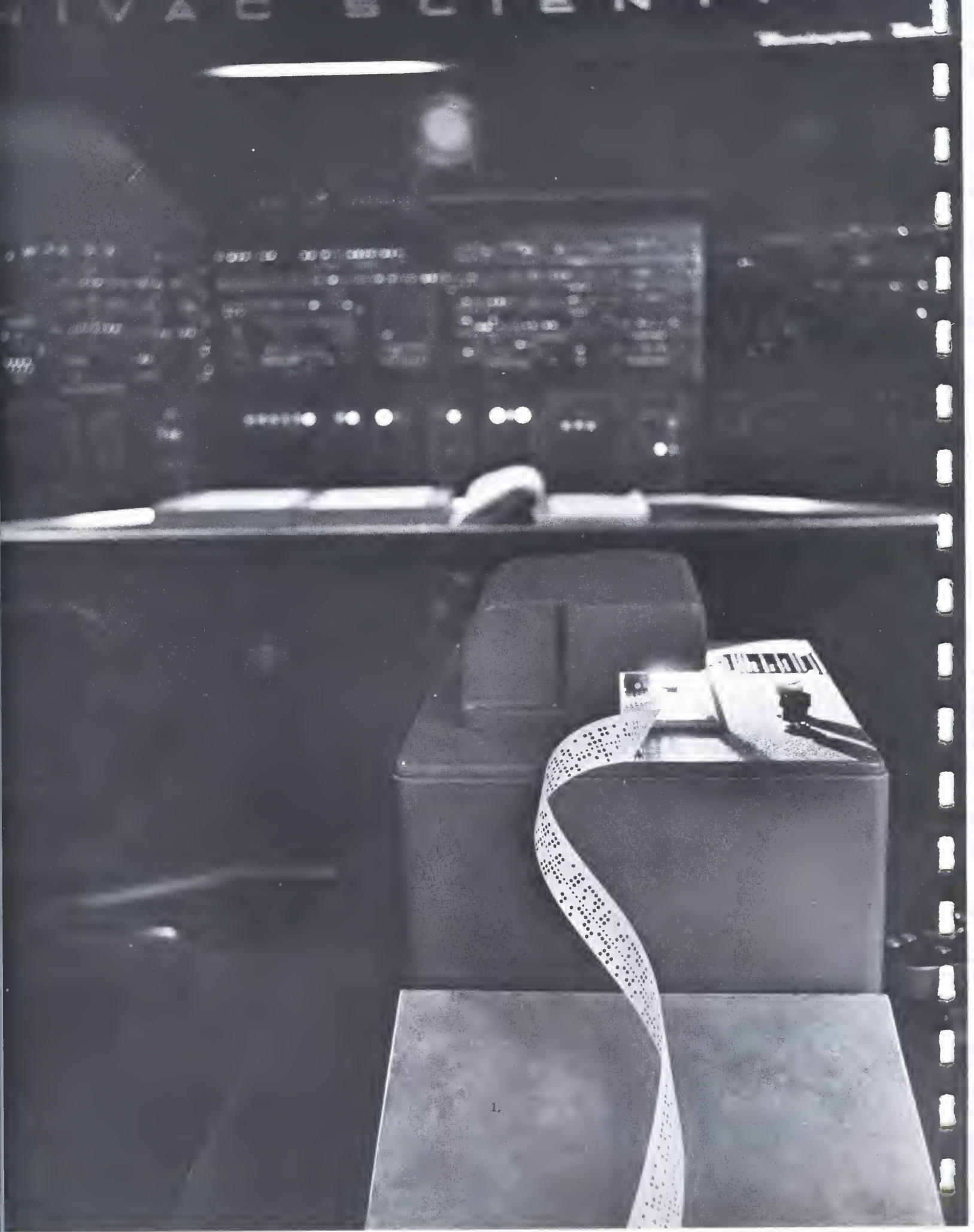
The programmer's flow chart ends here at the computer console.

Even after the problem has been defined, the parameters set, and all unknowns clarified, the method of solution may itself require study. This is programming—the preparation of instructions for the system. It involves analysis of the source data; the determination of what is to be done with such data, and the technique to be used. Programming is the function of specialists, primarily mathematicians, within the UNIVAC engineering department.

One of UNIVAC's most extensive programming efforts has been for the NAVAL TACTICAL DATA SYSTEM. This large-scale effort has included design, coding, and verifying (debugging) of all programs for the NTDS computer with its peripheral equipment, keysets, communication terminals, and video processors. An automatic compiler developed for the project emphasizes verifying and record keeping for the large number of sub-programs.

UNIVAC's programming staff is continually working to supply its customers with simplified methods of programming and better use of languages for expressing problems for a computer. Present investigations are involved in the development of a standard programming package for delivery with each UNIVAC computing system. Work involves study and evaluation of such universal machine languages as ALGOL and COBOL—that is, the development of compilers for expressing the solution to problems in problem oriented language (routines which interpret non-machine language and translate it into machine code for the computer).

Another programming aid being developed is an assembly language for expressing problems of a more specific nature —for use where a section of a program



1. Light reading for a computer: paper tape input to the UNIVAC SCIENTIFIC.
2. Programmer's world.

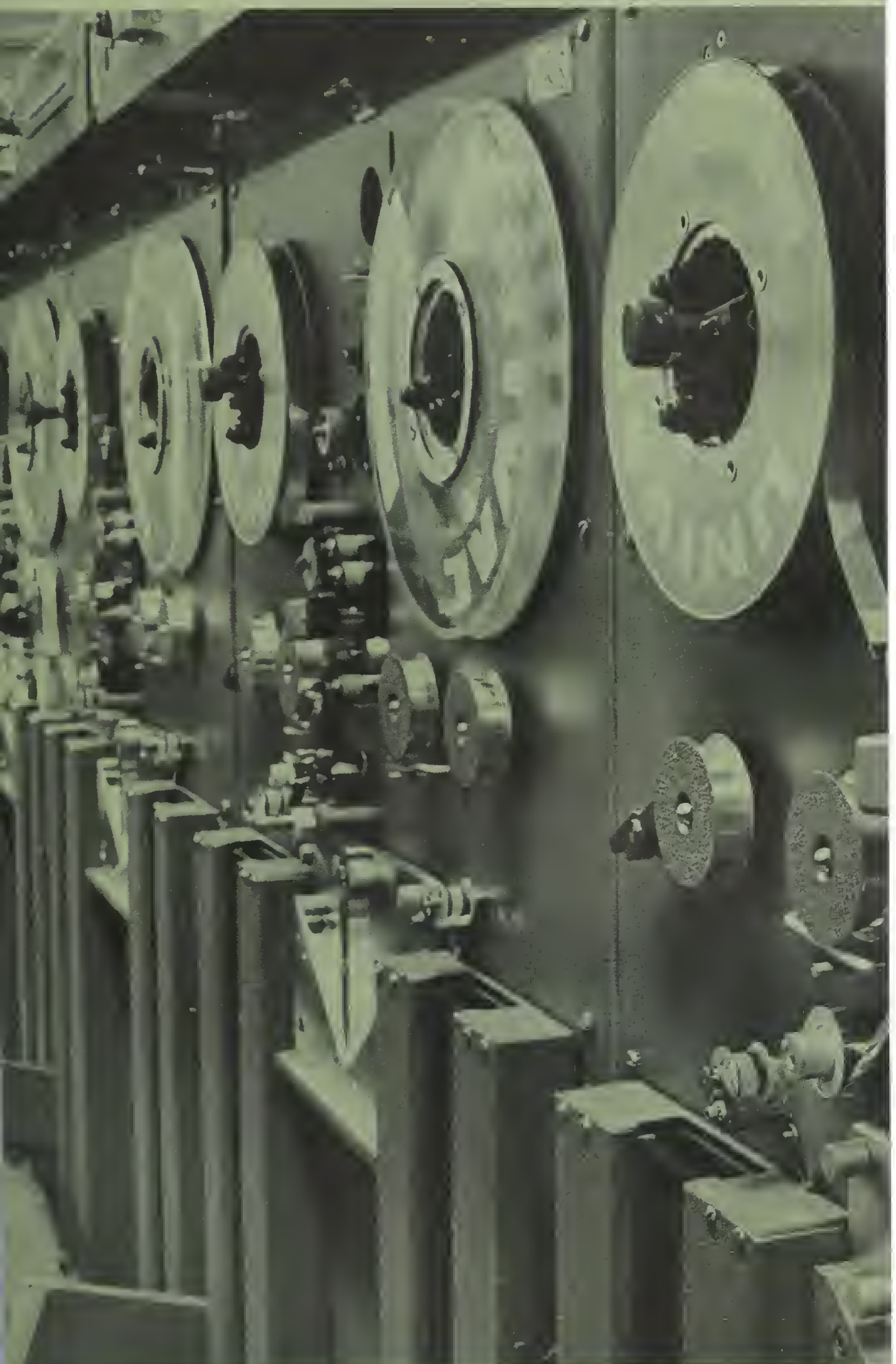
may be used many, many times and not require the universal language characteristics of a compiler.

A third area of development is involved with verifying routines to assist the customer in checking out his program. These are utility routines that will be included in the initial package. They include a routine for comparing the contents of a program or data area against a selected image . . . a routine for detecting all words in the computer memory which reference a particular address . . . and a routine for printing the contents of all locations within a specified memory area.

A new concept in programming being investigated is an executive routine which controls many of the activities of a computing center. The executive routine will be capable of scheduling the most efficient way of processing a designated work load—and of directing the manipulation of several problems at a time.

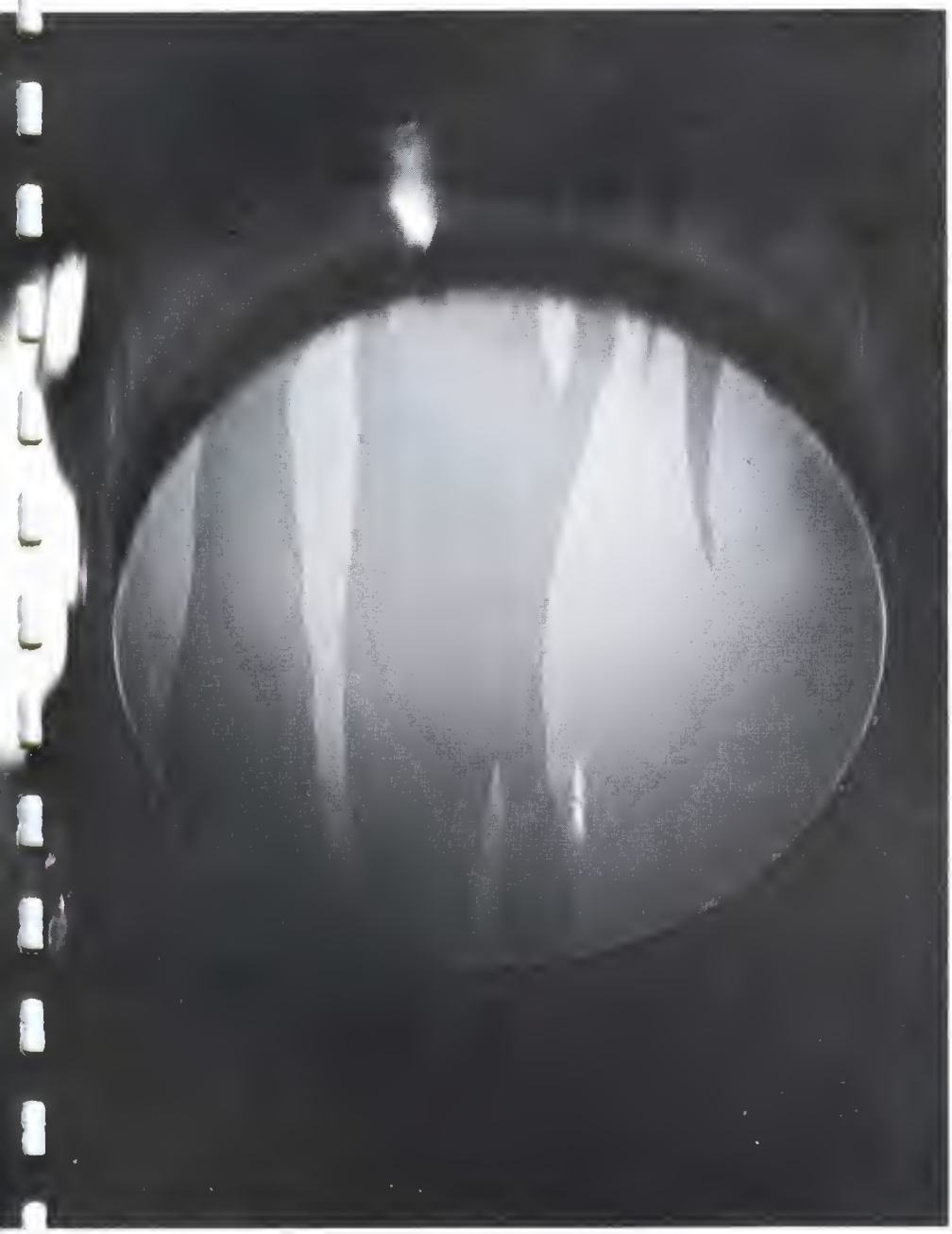
UNIVAC has led the industry in programming since it first pioneered methods for simplifying communications with a computer. Two results of continuous coding studies are the famous UNIVAC compilers—FLOW-MATIC and MATH-MATIC—now in everyday use.

UNIVAC UNISERVOS.



RESEARCH

COLOR PHOTO. Not a map of Mars, but the crystalline structure of brass magnified 800 times.



Wall-motion switching in a magnetic film memory cell (magnified 50 times).

The most important characteristics determining the capability and versatility of a digital computer are the capacity and speed of its internal memory. The attainment of memories with sufficiently large storage capacity and short enough cycle time at a practical cost has been the principal barrier preventing wider exploitation of digital computers. For this reason, one of the most promising areas being investigated by UNIVAC's research staff is ferromagnetic films—and the devising of techniques for using logical arrays comprised of such films.

Ferromagnetic film elements have exceptional potentials for both memory and logic functions in data-processing control systems. With the same or even less power, the state of a magnetic film can be switched 300 to 1000 times faster than the state of a typical ferrite memory core; that is, in a few nanoseconds (billionths of a second). The Department is presently testing an experimental computer utilizing a magnetic film memory to store 1000 24-bit words (this can be expanded) with a cycle time of less than 100 nanoseconds.

However, a practical limit is imposed on the memory size (for a fixed cycle time) by the inherent pulse delays. This is an area of intensive research at UNIVAC. Three conditions must be fulfilled in order to effectively operate magnetic film memories. First, the total energy stored in one such element is so small that reasonable output signals are obtained only by very rapid switching of its magnetic state. Thus the electric current pulses which drive such elements must rise and fall in a very short time—preferably a few nanoseconds. Second, electric signals cannot be propagated faster than the velocity of light. To minimize delays, all lines and interconnections must be kept as short as possible. Thus miniaturization of all circuits is required. Third, since signals generated in the sense lines are small, the sense amplifiers must have large gain with minimum delay for the ultimate performance of such devices.

New techniques are being developed at UNIVAC for increasing the size of magnetic film memories by reducing pulse delays in logic and amplification, and also those delays due to element spacing and configuration. One solution is the reduction of storage element size. Another solution is the use of magnetic film elements in word selection matrices, thus

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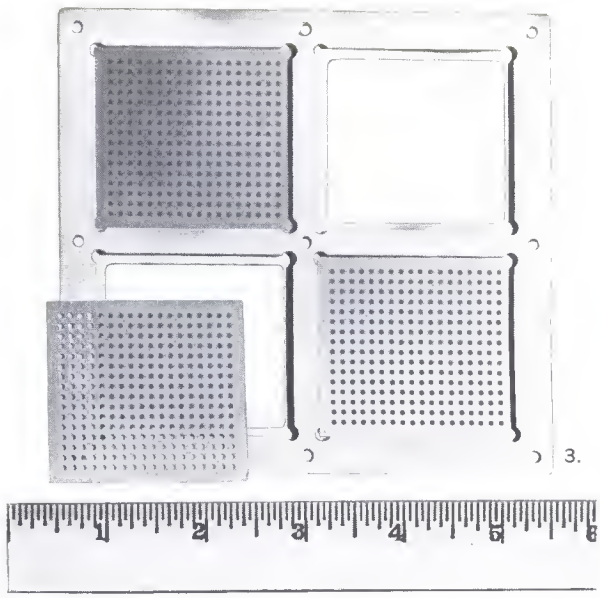
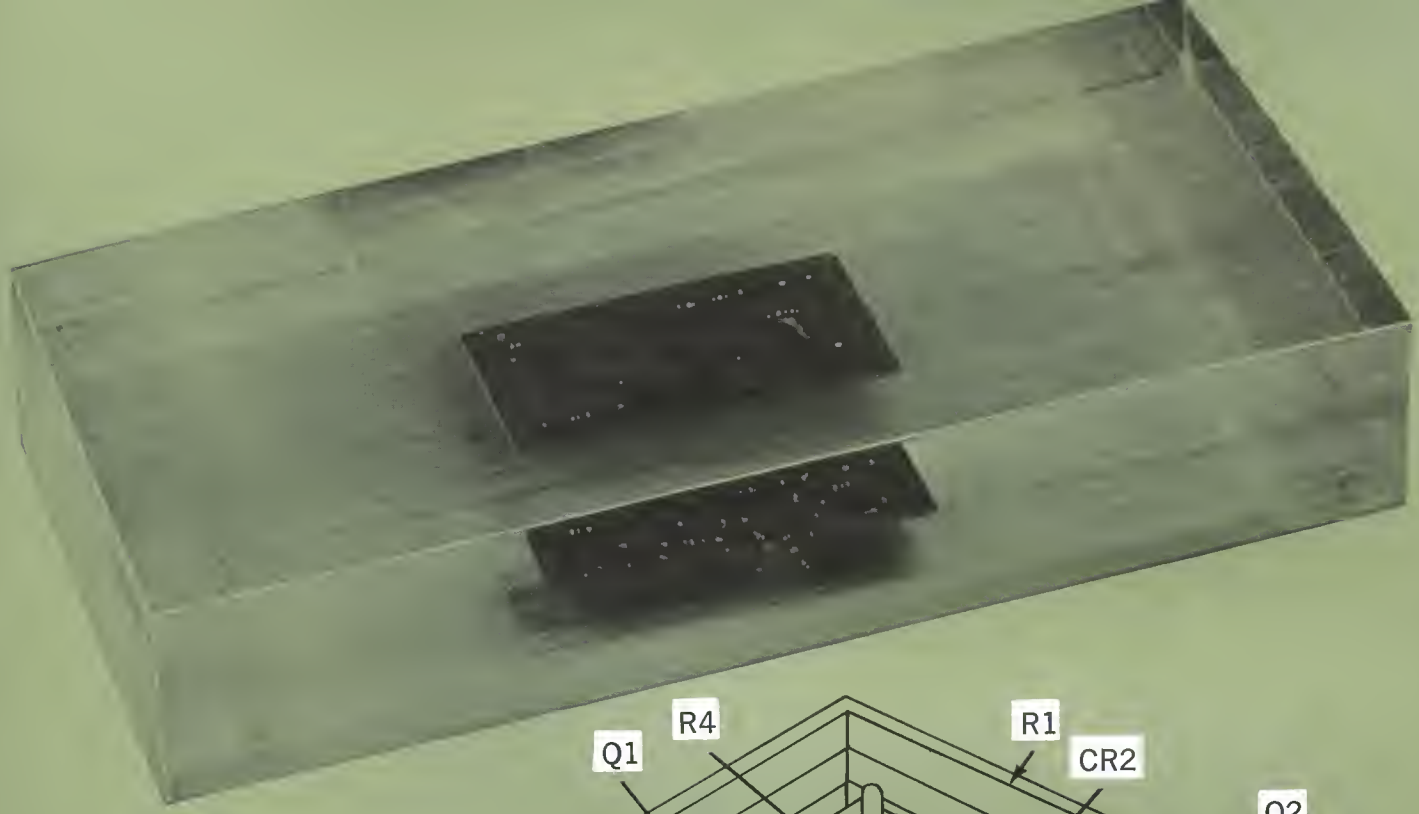
2.



3.

1. In studying ferromagnetic domain structure, the electron microscope magnifies 200,000 times.
2. Magnetic film switching speed measurement.
3. Magnetic film memory mask.
4. Interferometer patterns for thin magnetic film analysis.



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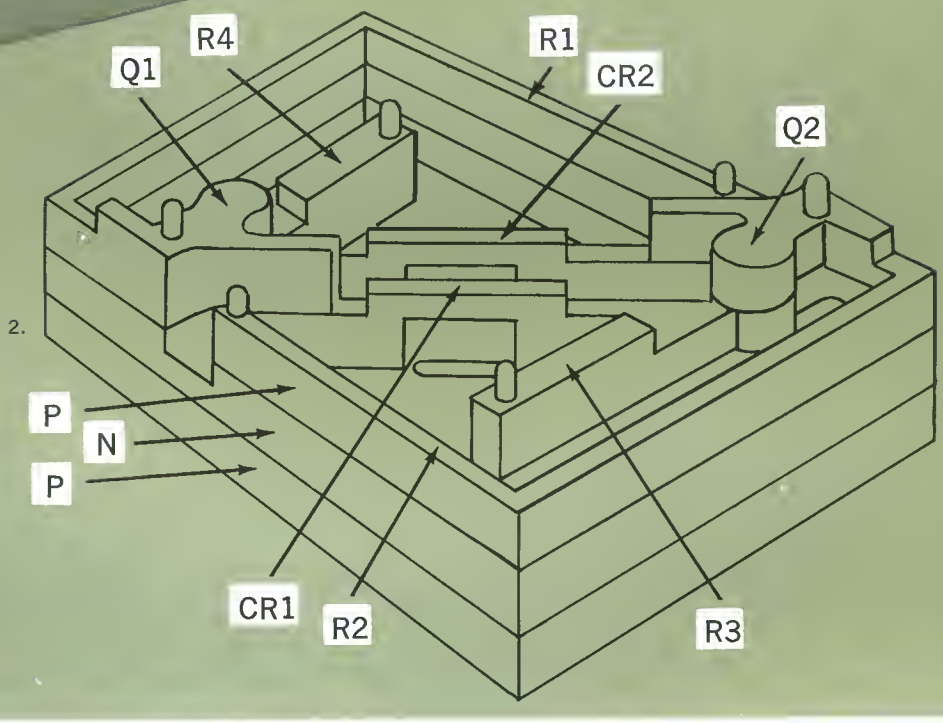


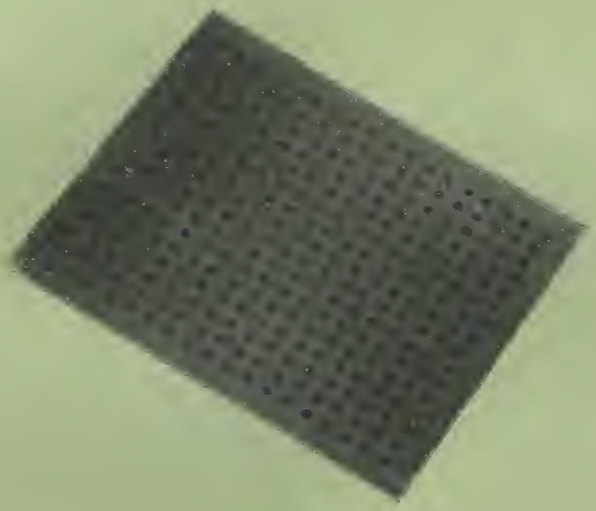
2.

making it possible to select words with fewer components.

UNIVAC has made rapid progress in its efforts to provide the peripheral electronic devices needed to operate magnetic film memories. One such promising device is the development and use of "microtronics." ("Microtronics," or microscopic electronics, is a new method of combining semiconductors having controlled and variable characteristics in a single package to form solid state systems.) The combination of "microtronics" and thin magnetic film is a joint effort of UNIVAC and Sperry Semiconductor Divisions of Sperry Rand Corporation. This effort is resulting in a new generation of ultrasmall, ultrafast computer components. The compatible magnetic film-microtronic memory gives more storage per cubic inch with less power consumption than any memory device known today.

When used in suitable arrays, magnetic film elements can also perform logical operations. UNIVAC investigations, comparing film-element logic with conventional counterparts, have resulted in subsystem designs which reduce the required number of semiconductor components, and greatly increase operating speed. These advantages—combined with small size, high reliability, low power requirements, relative insensitivity to environment, and low cost—make magnetic film elements extremely suited for logic devices.

Another potential application of magnetic film elements is their use in parametrons—devices capable of acting as oscillators, amplifiers, and the elements



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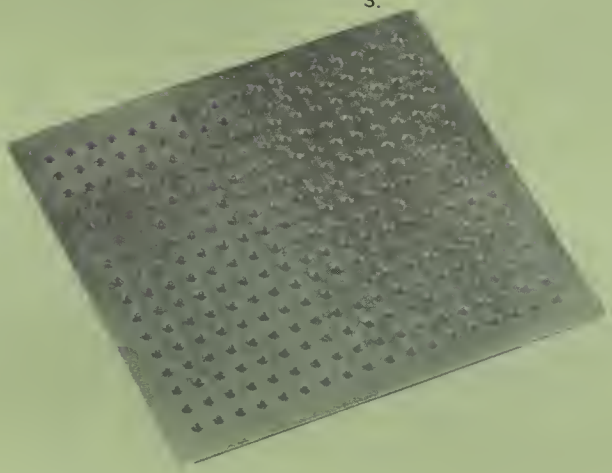
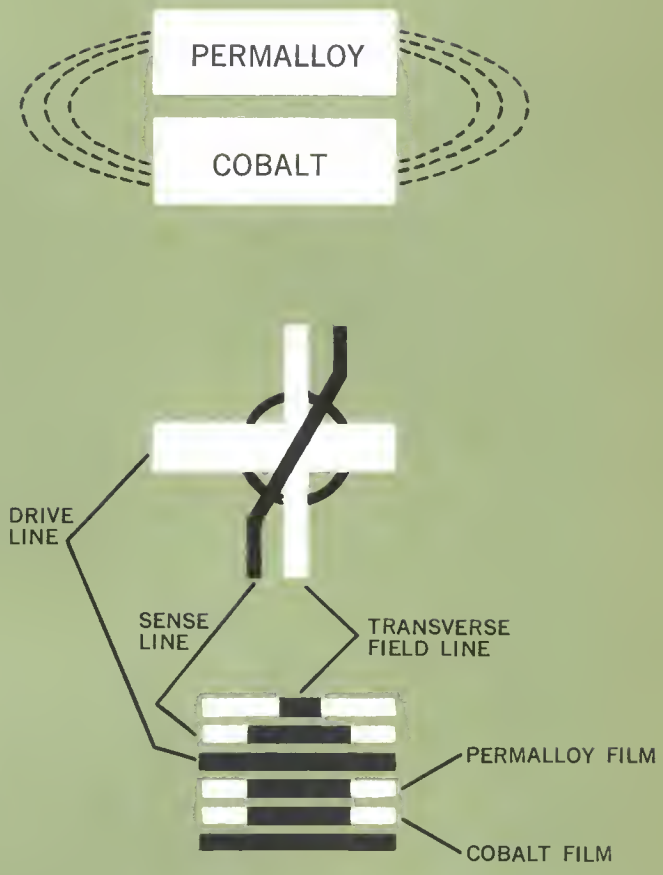


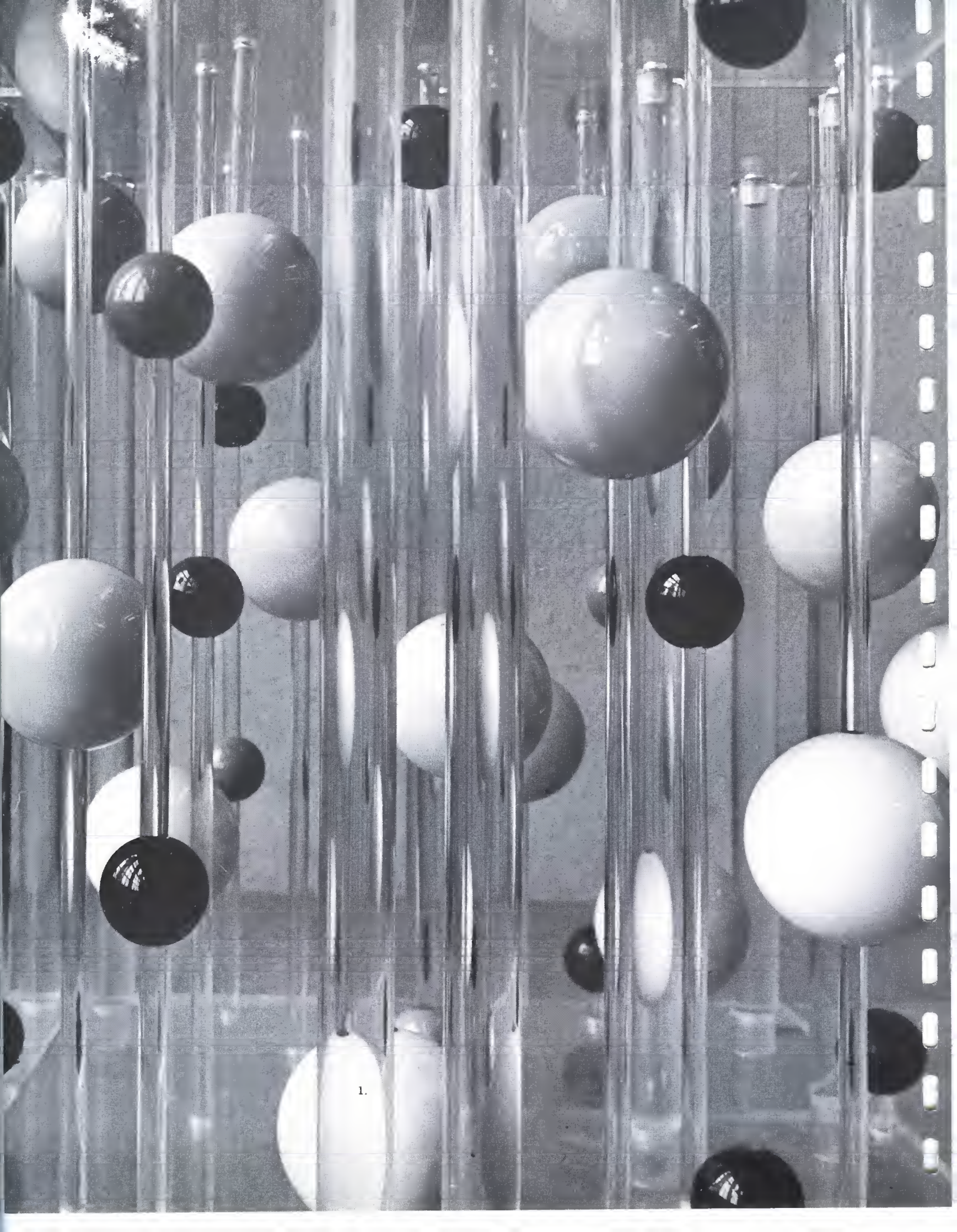


4.

of logical networks. As a logical device, the phase-locked parametric oscillator is a majority-decision element; that is, its output reflects the majority of its inputs. With such elements it should be possible to perform complicated logical operations using fewer elements—and far more economically.

UNIVAC research has also developed a new algebra of majority-decision logic which will greatly facilitate the design and development of systems employing majority-decision elements.

1. Blow-up of plastic encased "microtronics" module.
2. "Microtronics" module containing two transistors, two diodes, four resistors; approximate length is ½ inch.
3. Magnetic film mask and substrate.
4. Magnetic film memory element using two films of different alloy to obtain non-destructive read-out of information.



1.

Special applications of magnetic film memory techniques are now under development at UNIVAC. One application, using pairs of magnetic films as storage elements, is a highly effective non-destructive read-out memory with very rapid access time. It is extremely reliable since information can be read out at any time without the memory contents being altered.

Another type of film memory being developed performs rapid search of its own contents. This memory will search among hundreds or thousands of words to see if a given word is stored—and do this in a fraction of a microsecond. Experimental models of search memories have been constructed and are being tested.

MAGNETIC FERRITES is another area of research. Memories can be built efficiently at the present time in blocks of about 32,000 words. By suitably interconnecting the blocks, memories of this type, of perhaps ten times the present size, can be used efficiently. Presently attainable cycle time of these memories is in the order of one microsecond.

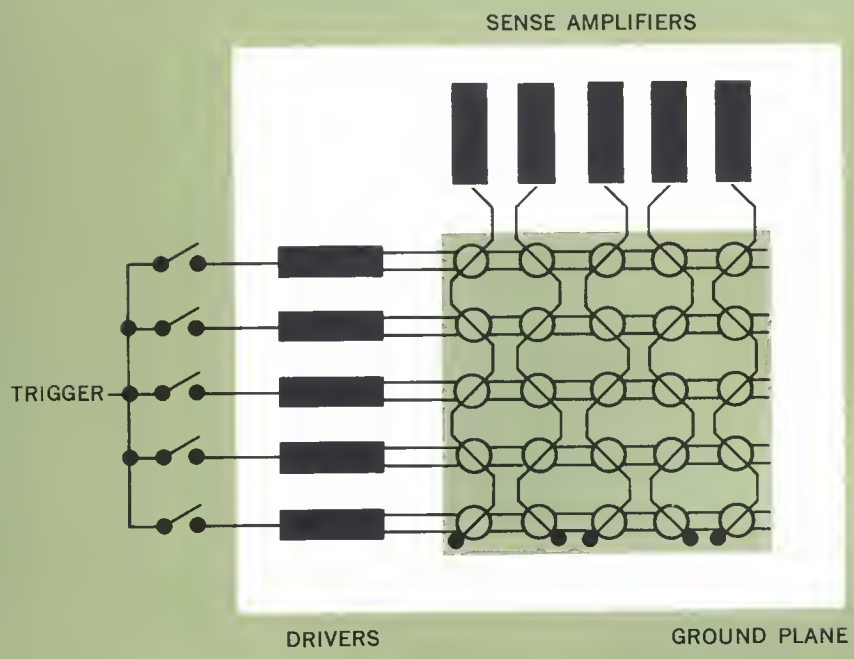
The UNIFLUXOR is a binary permanent memory element which uses the inductive characteristics of magnetically coupled wires. This UNIVAC device has been operated at interrogation intervals of 420 nanoseconds. Improvements in component and circuit response will speed up the operation of a memory system made from these elements.

Considerable research in *logical circuits and components* is also being carried out. For example, better packages for ultra-high-speed components are being developed. Such research involves placement of logic packages to reduce wire length, resulting in less delay, pulse distortion, and crosstalk. Component size reduction, interconnection simplification, package volume compression, and increased heat transfer are other areas of packaging research. Logical circuit and component investigations are being done in transistor-transformer coupled circuits, multi-element transistors, tunnel diodes, molecular electronics, magnetic film circuits, ferrite switching elements, and evaporated film cryotron circuits.

2.

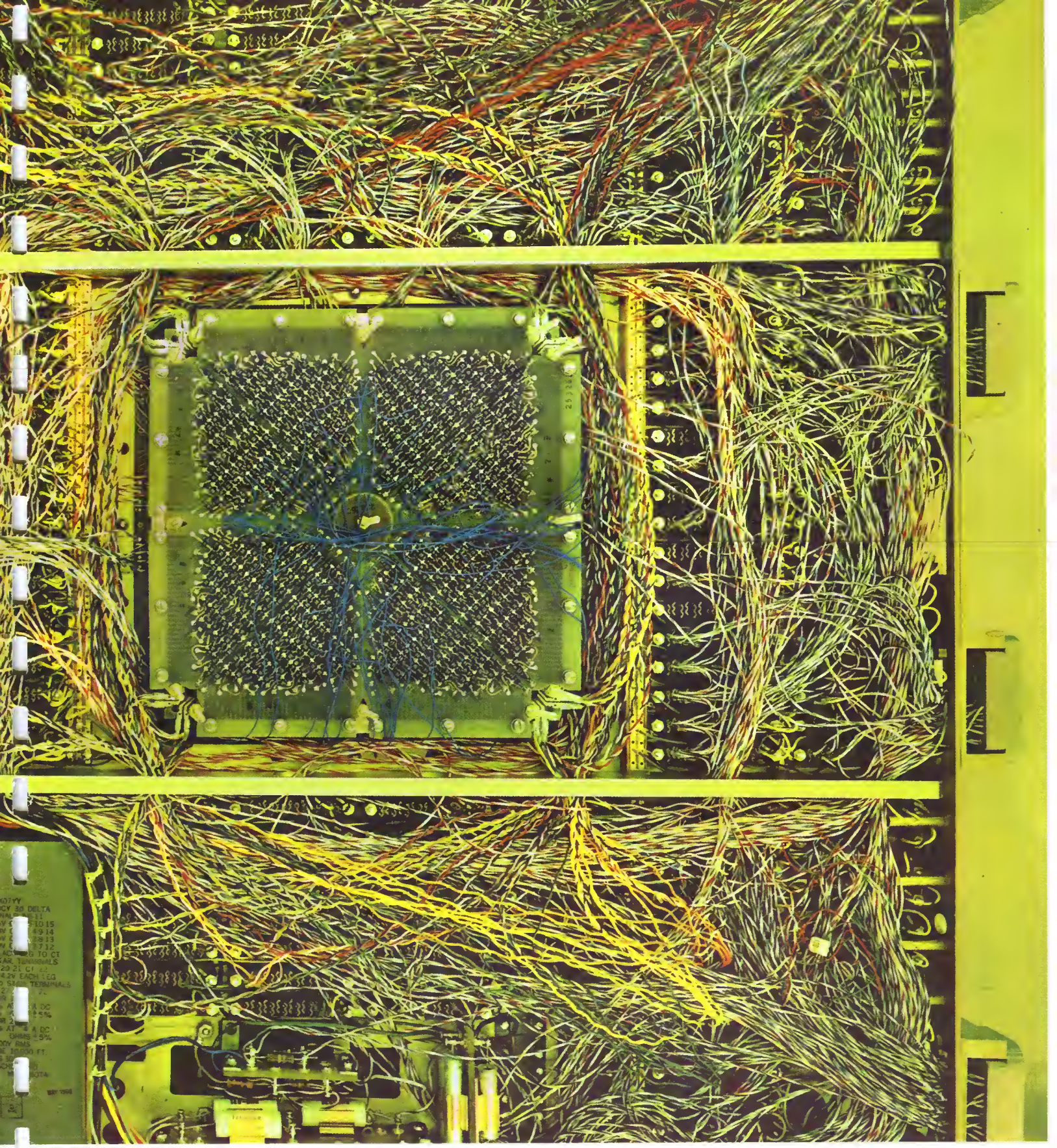
1. Ferrite crystal model.
2. Multi-layer printed circuitry for magnetic film memory.

THIN FILM MEMORY



Stylized diagram of magnetic film memory.

In the future, improved input, output, and display of data will undoubtedly be provided by other electronic developments. Direct photoelectric reading of printed information, direct verbal input to data-processing equipment, and improved techniques for rapid printing of output data will conceivably be in use within a few years. Also the development of self-teaching and self-adaptive systems will no doubt be much accelerated in the coming years. Many of the techniques and devices presently being developed by UNIVAC will contribute to the realization of such systems.



MANUFACTURING

COLOR PHOTO. UNIVAC 1206 "bootstrap" memory: diodes provide permanent storage for automatic recovery from program error.

Manufacturing starts when the project begins. This is UNIVAC's philosophy of concurrency, one of the major factors contributing to the Military Department's ability to produce ultra reliable systems on time.

A formal organization of industrial engineers, plant engineers, and production engineers is responsible for engineering the way in which the product is built. Prior to the time a contract is entered, this group is already at work solving such questions as: "What processes are required? . . . tools? . . . space? . . . facilities? . . . equipment? . . . training?" Every manufacturing process is considered, every facility is anticipated—and available when needed.

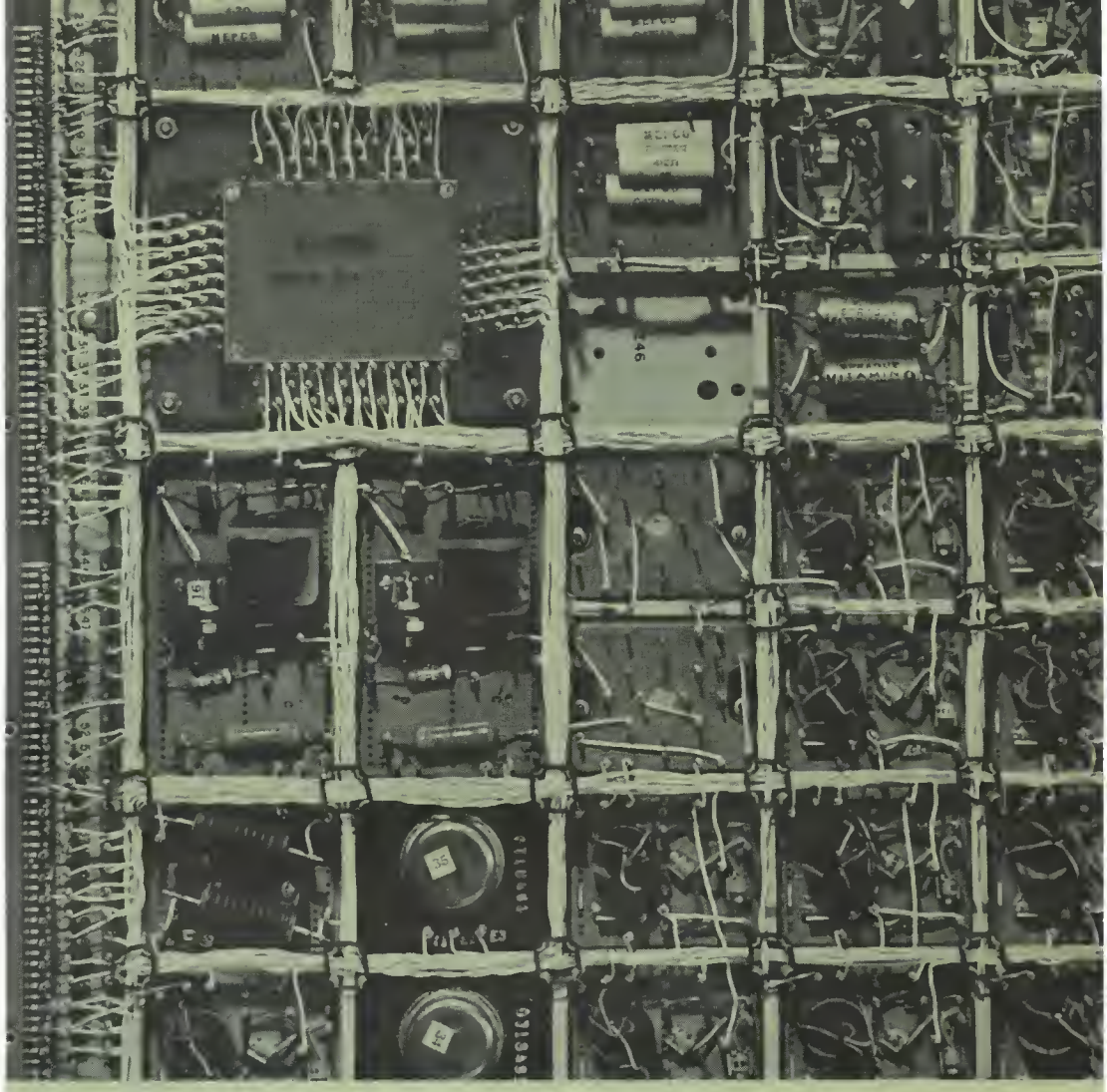
When new developments occur in computer design, UNIVAC manufacturing is ready to implement them. A special organization, ADVANCED MANUFACTURING TECHNIQUES, is working two to five years in advance of production. This staff consists of personnel experienced in electronics, metallurgy, and chemistry. Its activities include the research, design, and development of advanced manufacturing techniques, processes, tools, facilities, and test equipment. It designs and builds pilot line equipment—trains manufacturing personnel in the application of new processes and techniques, and in the operation of new equipment. Currently, design and development activities of this group are concerned with a process for mechanizing the manufacture of memory planes—equipment for thermo-compression bonding—manufacturing techniques for welded components—production equipment for magnetic film and deposited memory arrays—a manufacturing process for microtronic components. Through efforts such as these, UNIVAC manufacturing has kept pace with the exceedingly fast progress in data handling made by research and development.

Assembly of critical parts is a "clean room" operation with temperature and humidity control, white smocks and gloves for all operators, and strict quality control. Policy prohibits touching components with the bare hands. Any component that is dropped, even in a container, is retested. Rework is strictly controlled and limited.

Assembling a ferrite core memory.

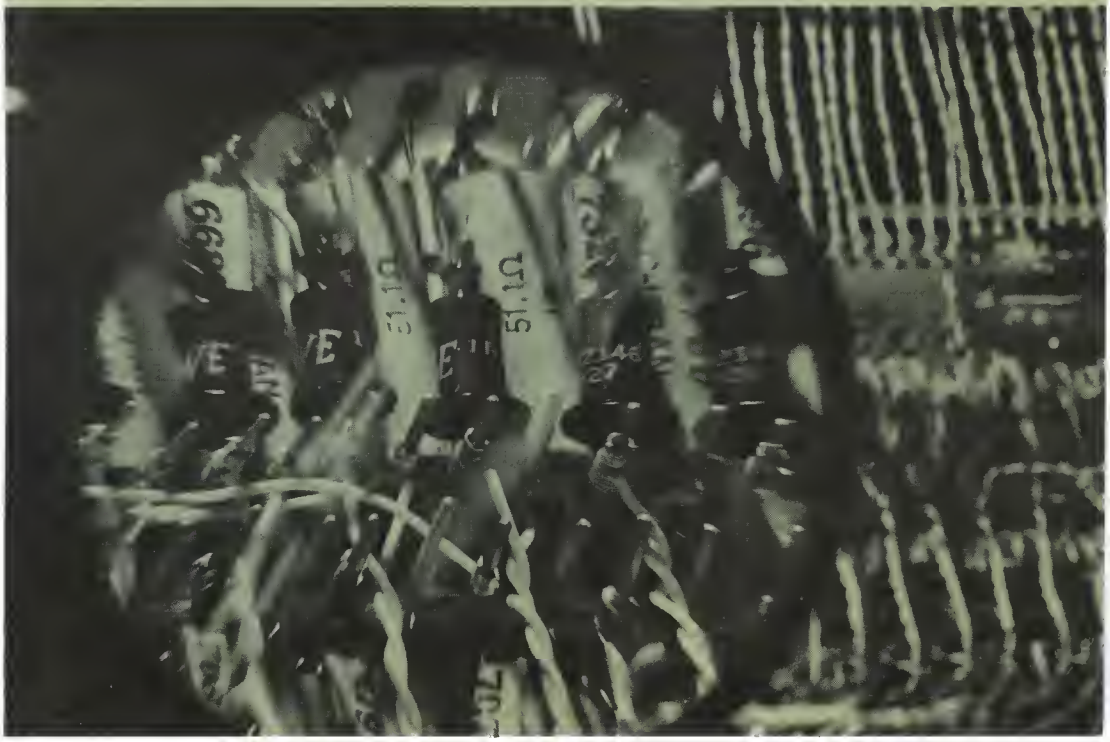
1.

2.



1. Sorting ferrite memory cores.
2. Assembly of "A" modules into "C" planes prior to testing and inserting into Nike Zeus Target Intercept Computer.
3. Wire wraps: connections without solder.

3.



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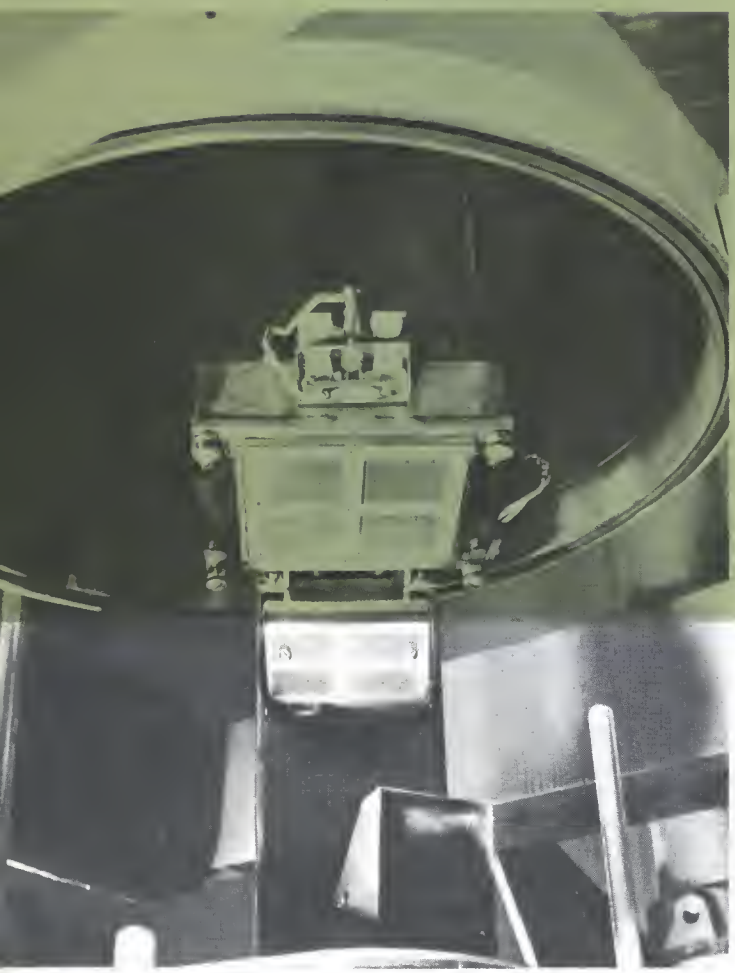
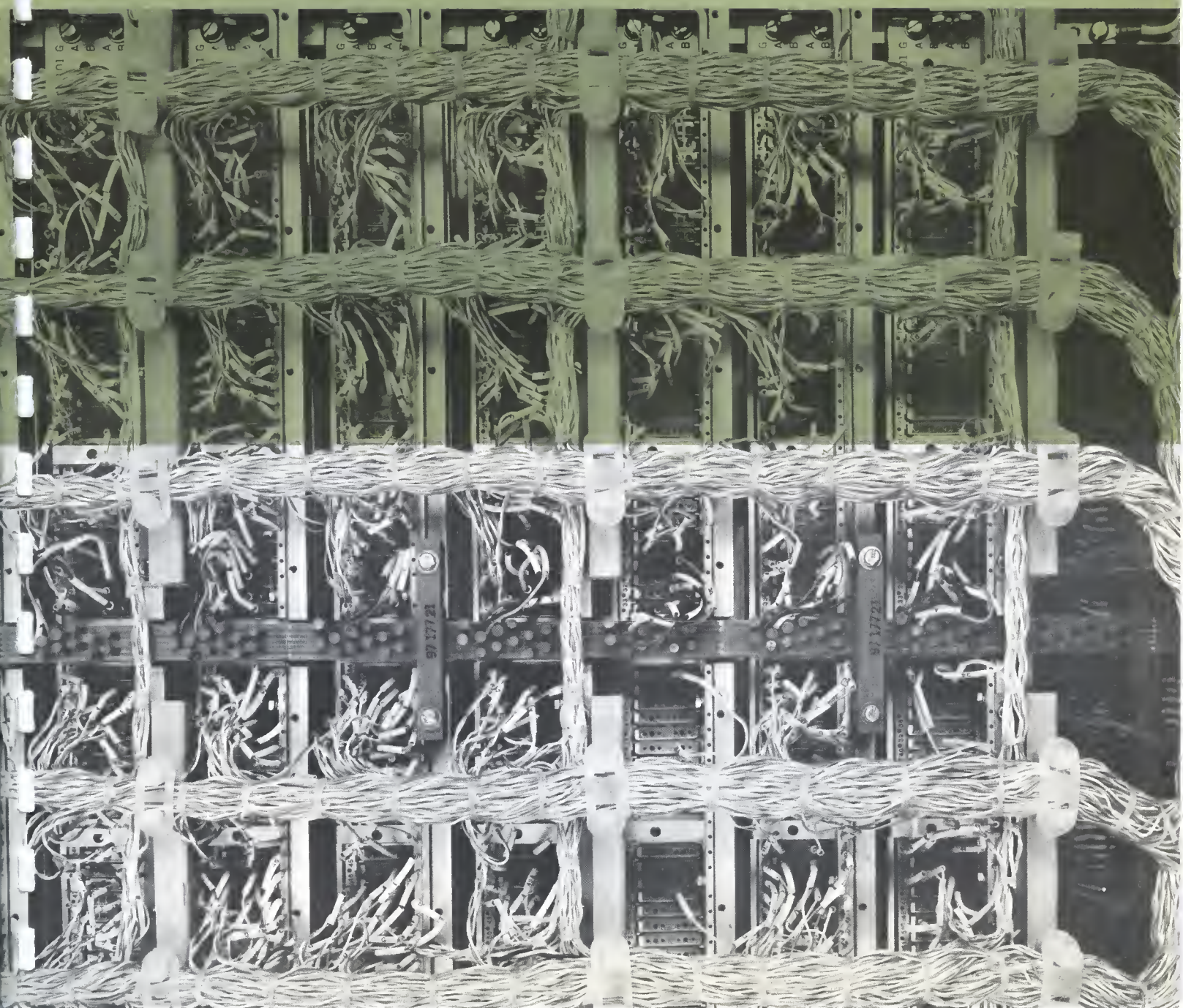


2.

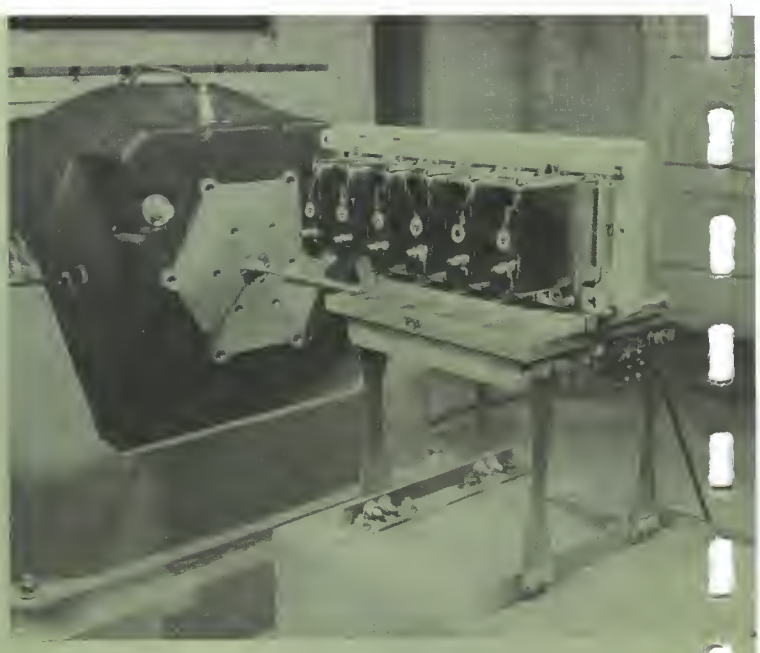
1. Vacuum chamber: depositing thin magnetic films.
2. Magnetic film vacuum laboratory.
3. Central nervous system: rear view of UNIVAC 1206 chassis assembly.

3.



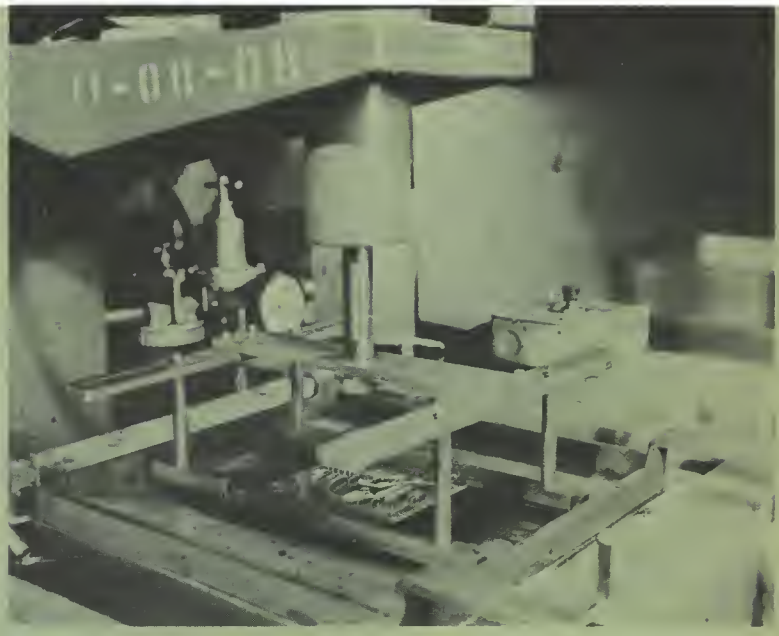
Thorough, detailed quality control checks are maintained throughout the entire project effort—beginning with design and continuing through installation. A manufacturing quality assurance group studies initial designs, making sure that military specifications have been followed. Activities of this group include complete on-site checks of vendor facilities and processes. Periodic reports are submitted on the vendor's operation. The final assurance that only reliable components are used is the complete test of every component before it is put into the system. This is a cumulative, controlled testing method that literally results in quality being built in. Special system and unit tests are made on each section of the system. Each assembly is tested, and as new components are added, the assembly is tested again—until finally, the composite assembly is checked. For final, extra assurance of reliability, tests are made to and from inspection stations to determine any effect on reliability as a result of testing. UNIVAC's extensive quality control program has been found to result in economy as well as reliability. It has yielded substantial reductions in equipment debugging time, as well as more accurate estimates of delivery. The cost of the program is far outweighed by savings in logistics and maintenance.

Incubators for "microtronics."

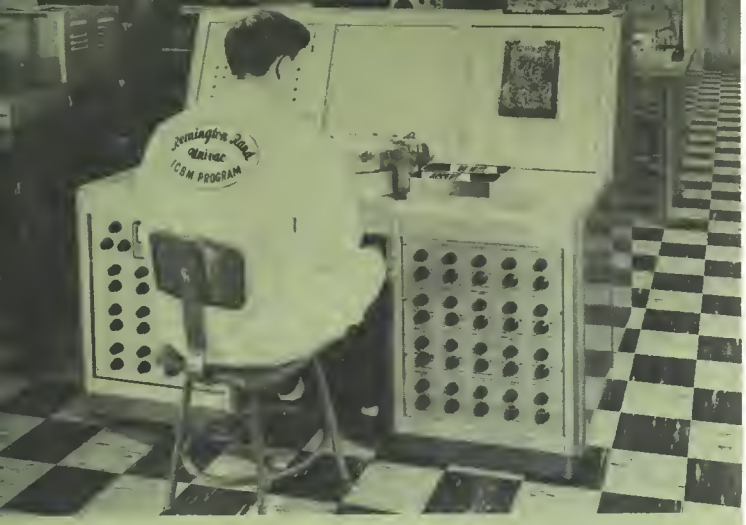


Shaking out potential failures.

Baking out the survivors.

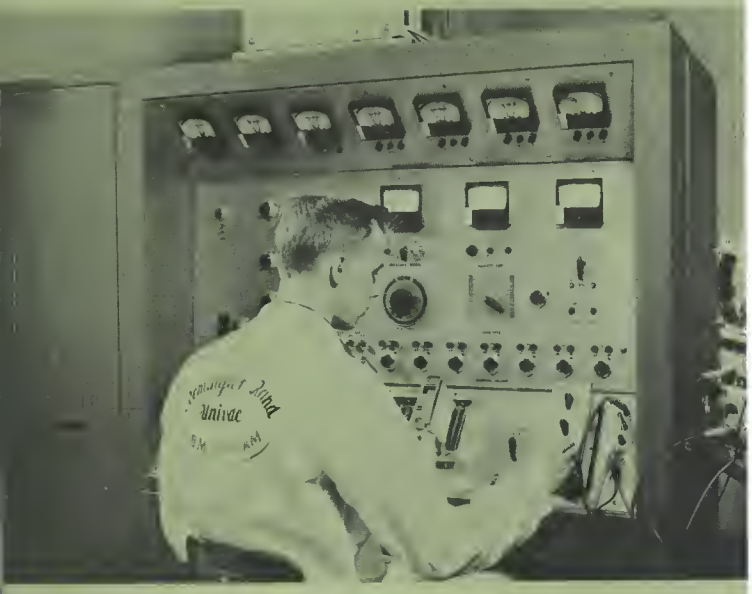


Automatic dip soldering.



Automatic component testing.

Final inspection of logic modules.



FIELD MAINTENANCE AND TRAINING

COLOR PHOTO. Much of ATHENA's maintainability is the direct result of simplified modular design.

FIELD MAINTENANCE AND TRAINING provides assistance to the military in the installation and maintenance of UNIVAC equipment—in all areas of parts supply and equipment modification—and in the training of personnel in equipment use.

In the strictest sense, Field Maintenance and Training functions as the customer's representative—both in the field and within the Military Department. The group's activities begin, not with installation, but in the pre-design stage of the program. Field engineers are particularly concerned with design from the viewpoint of maintainability and checkout . . . with such questions as the number of men required to maintain the system—the kind of men—the kind of parts—and the personnel, location and amount of time required for repairing the equipment.

Mobile Ground Support Equipment.

Digging in for ATHENA: Titan site in Colorado.

1.

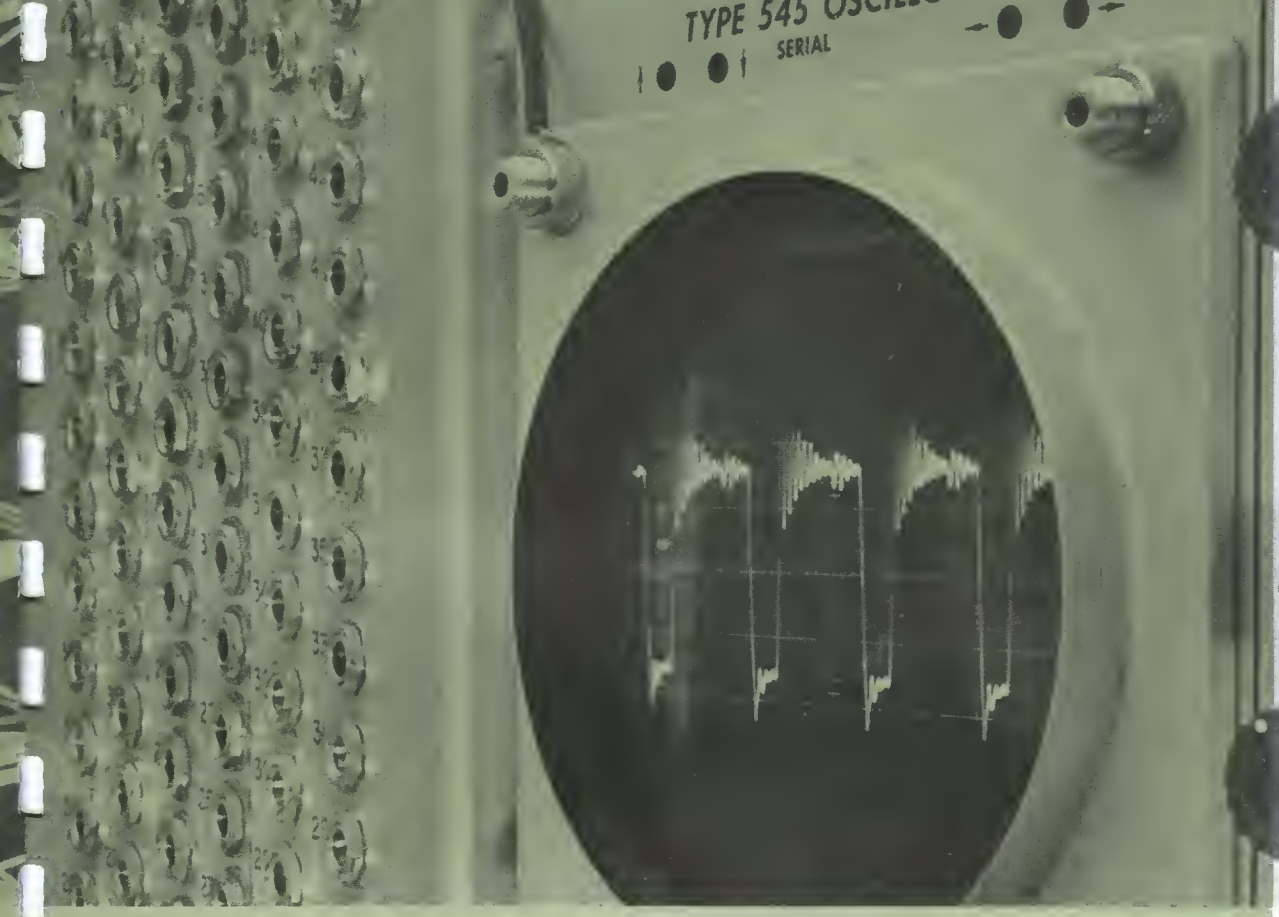
The group's field engineering activities are both operational and logistic. They include:

- evaluation of engineering design for maximizing maintainability
- determination of type, level, and location of maintenance
- establishment of preventive and corrective maintenance programs
- installation and checkout of systems
- performance of contractor maintenance
- preparation of consumption and failure data reports
- maintenance and operation of parts depots
- allocation and control of parts for installation, maintenance, and operation
- control of repairs and modification of system components

Field Maintenance and Training has trained thousands of military and civilian personnel in programming, operating, and maintaining high-speed data-processing systems. Such training programs have been initiated for the Naval Tactical Data System, the Tactical Air Control System, the ATHENA computer for ICBM, the Target Intercept Computer for Nike Zeus, and the Sea Surveillance program. The group's training activities include three primary responsibilities:

- development of maintenance and operator training programs
- implementation of programs through personnel training—for the military and associated contractors, and for its own group as well as for other company divisions
- preparation of qualitative requirements for operative and maintenance personnel

Field engineering is an integral part of the UNIVAC product cycle. The intelligence gained from field engineering reports—reliability reports, failure reports, special reports, as well as information gathered from customer conferences—has ultimately resulted in more easily maintained and operated equipment, and in the greatly increased operational reliability of all UNIVAC products.



2. 3.

1. Pulse beat for Nike Zeus.
2. NTDS installation.
3. "Now this register . . . "

9 . . . 8 . . . 7 . . . 6 . . . Countdown for tomorrow's computers.

REMINGTON RAND UNIVAC, Univac Park, St. Paul, Minnesota.

U 2857

Printed in U.S.A.

UNIVAC at St. Paul occupies seven plants with a total area of nearly one million square feet of floor space, and employs over 5,000 people. The latest addition to UNIVAC facilities in the St. Paul area is a plant in Roseville built for the production of the new UNIVAC® 1107 Thin-Film Memory Computer and the UNIVAC 490 Real-Time System.

UNIVAC at St. Paul dates back to 1952 when Remington Rand purchased Engineering Research Associates, Inc. In 1959 the St. Paul operation was designated the UNIVAC Military Department. Today, commercial product development is a vital part of the UNIVAC Progress Story. Positive proof of the dramatic steps forward is evidenced by the UNIVAC 1107 and the UNIVAC 490 Real-Time System. All pre-production work on these two powerful computer systems was done here at St. Paul.

UNIVAC heads the list of local electronics industries responsible for ranking Minneapolis-St. Paul fourth among the nation's major centers of electronics activity.

BACKED BY 90 YEARS OF EXPERIENCE, MORE THAN 17,000 EMPLOYEES AT ALL UNIVAC FACILITIES ARE DEDICATED TO PRODUCING THE WORLD'S MOST EFFICIENT AND ECONOMICAL COMPUTING EQUIPMENT.

UNIVAC
UNIVAC PARK, 2750 WEST SEVENTH BOULEVARD, ST. PAUL, MINNESOTA

U-2923 PRINTED IN U.S.A.

Aside from the facilities you have seen here at St. Paul, UNIVAC maintains modern engineering centers at Philadelphia and South Norwalk, Connecticut and manufacturing plants at Ilion, Elmira and Utica, New York, and Philadelphia and South Norwalk.

WELCOME TO UNIVAC—ST. PAUL

A brief introduction
to the facilities and operations of
UNIVAC in the Minneapolis-St. Paul area

UNIVAC-St. Paul is proud of its facilities and personnel and welcomes the opportunity to show you a few of the many operations in research, design, development and production of the famous UNIVAC line of computers.

LET'S TAKE A TOUR

- A demonstration of *Randex*—large mass storage system—with the UNIVAC Solid-State Computer.
- A look into the Drum Development Engineering Laboratory.
- You'll see the Thin-Film Laboratory—Actual production of thin-film memory for computers.
- A trip through the Nike Zeus Assembly Area—where Target Intercept Computers are being produced.
- A visit to the FAA Teleprocessing Area—where Flight Control Systems are being developed.
- An opportunity to watch UNIVAC 490 Real-Time Central Processor in operation.
- And stopovers at other areas—including the first computer-designed computer—the Athena Missile Guidance System.

MAP OF UNIVAC—ST. PAUL PLANTS

PLANT

1 2750 West Seventh St.
2 1902 West Minnehaha Ave.
3 475 North Prior Ave.
4 County Road "B" & Highway 36
5 640 North Prior Ave.
6 758 South Mississippi River Blvd.
7 640 North Prior Ave.